W. A. McClelland,
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HANDBOOK OF
DISEASES OF THE EAR

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DISEASES OF THE EAR

FOR THE USE OF STUDENTS AND PRACTITIONERS

BY

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WITH FOUR COLOURED PLATES AND
77 ORIGINAL ILLUSTRATIONS

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INTRODUCTORY NOTE TO FIRST EDITION

THE writer takes this opportunity of expressing his indebtedness to Dr. C. Herbert Hall for his kindness in revising the manuscript, and also his appreciation of the trouble involved.

LONDON,
October, 1903.

THIRD AND FOURTH EDITIONS

* 'TEMPORA MUTANTUR ET NOS MUTAMUR IN ILLIS.'

Figs. 29, 31, 33, are from drawings supplied by Mr. Harold Mole, F.R.C.S., of Bristol, who also revised much of the manuscript for the latter edition.

LONDON.

* The Times are changed and we with them.

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PLATE I

ACUTE CONDITIONS

1. Right tympanic membrane in early stage of acute otitis media, showing enlargement of vessels, loss of lustre of membrane, swelling and redness of handle.

2 and 3. Striæ of the membrane, right and left, after attacks of acute otitis media, which have subsided without suppuration.

4. Acute otitis media : collection of pus in posterior superior quadrant causing pouching of the drum ; spot of pus exuding from perforation.

Acute tuberculous otitis media : bulging of whole posterior segment, which is dull and with enlarged vessels coursing over it.

6, 7, and 8. Hæmorrhagic otitis media of right tympanum.

9. Acute serous otitis media in gouty subject, showing excessive vascularity.

10. Acute serous otitis media, showing dark line at upper edge of fluid, which is slightly too dark in colour.

11. Rupture of tympanic membrane (right) ; small perforation at tip of handle from direct violence.

12. Acute otitis, with formation of sanious bulla in meatus, which is contracted by exostoses.

[*To face Plate I., p. 1.*

PLATE I.

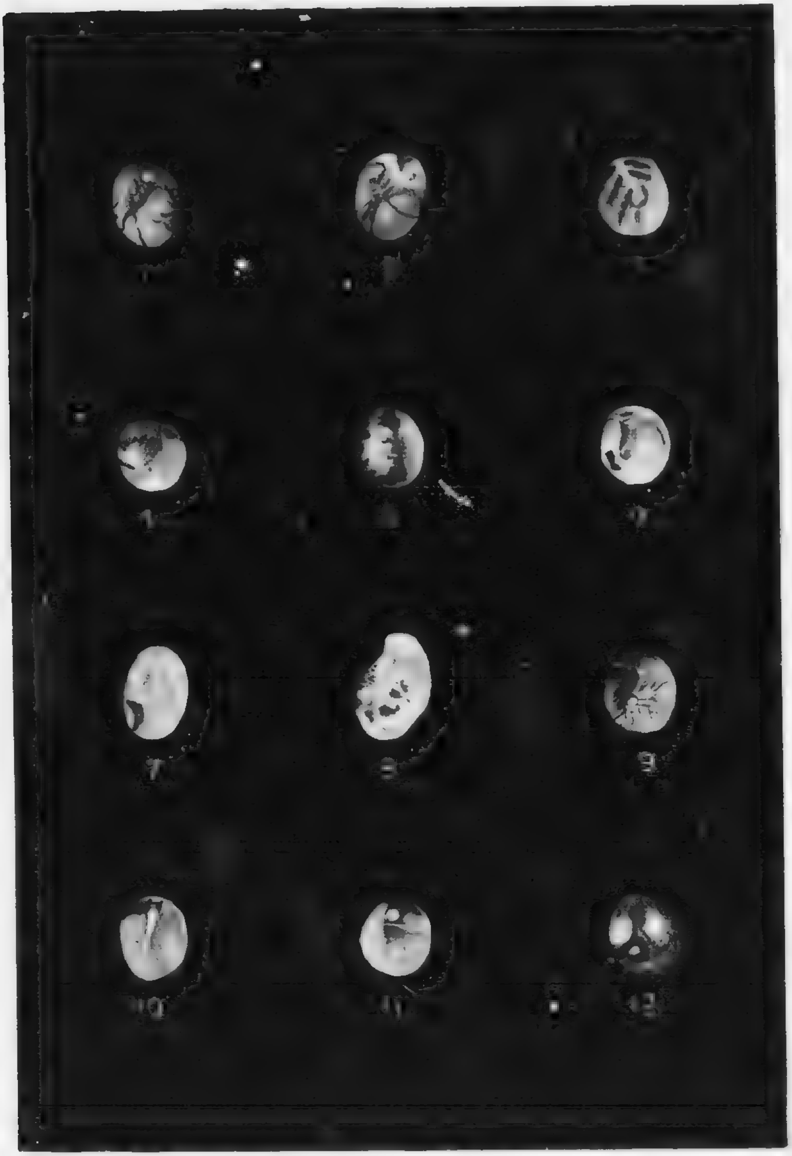
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PLATE II

CHRONIC NON-SUPPURATIVE CONDITIONS

1. Left tympanic membrane: much retraction of malleus directly inward; cone of light almost absent; crescentic margin of membrane much thickened.
2. Irregular thickening of the drum.
3. Showing irregular retraction.
4, 5, 6, and 7. Irregular local retractions of membrane.
8. Handle appears to project beyond the vertical line; long process of incus visible posterior to malleus.
9. Excessive retraction of malleus, so that it lies against the posterior fold, here very white, prominent, and distinct.
10. Distension (aerial) of lower quadrants of membrane, the upper being calcareous.
11. Distension (aerial) of lower and posterior part of membrane after long employment of auto-inflation (Valsalva's method).
12. Calcareous degeneration of tympanic membrane, involving posterior segment, and a portion of anterior superior quadrant; the remainder of the membrane irregularly thickened.

[*To follow Plate I*.

PLATE II.

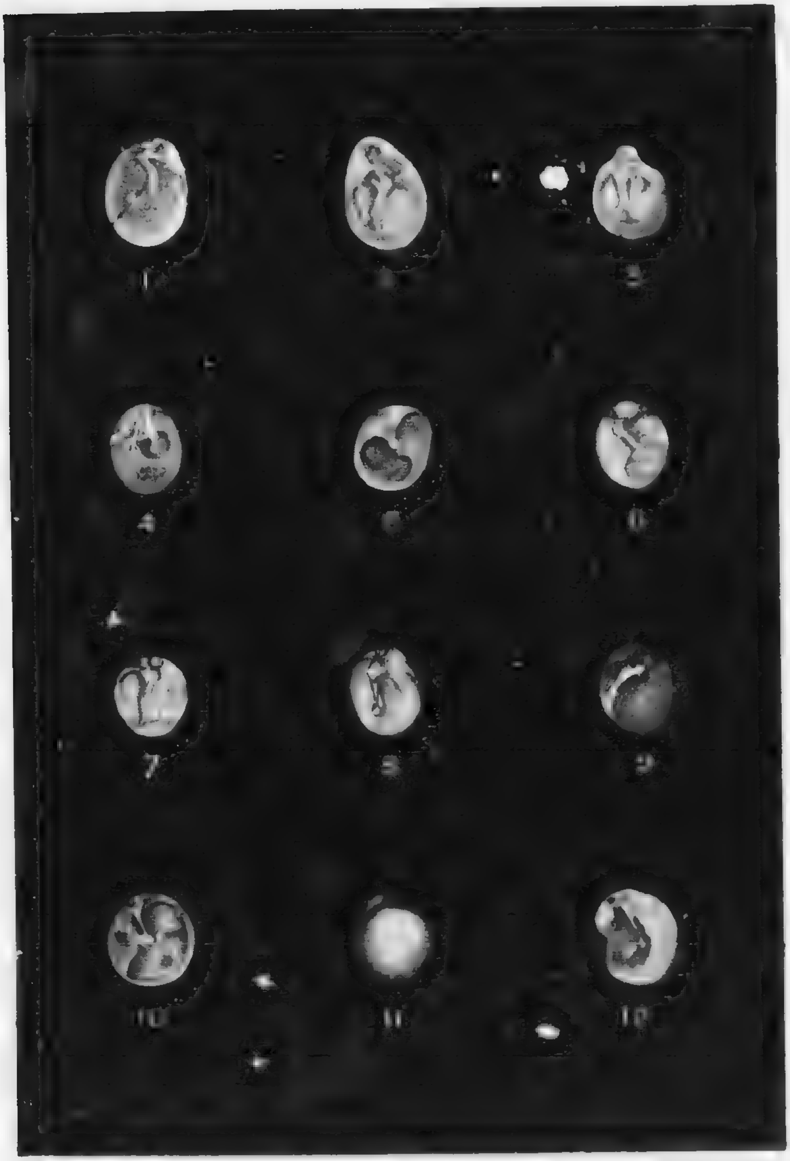
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PLATE III

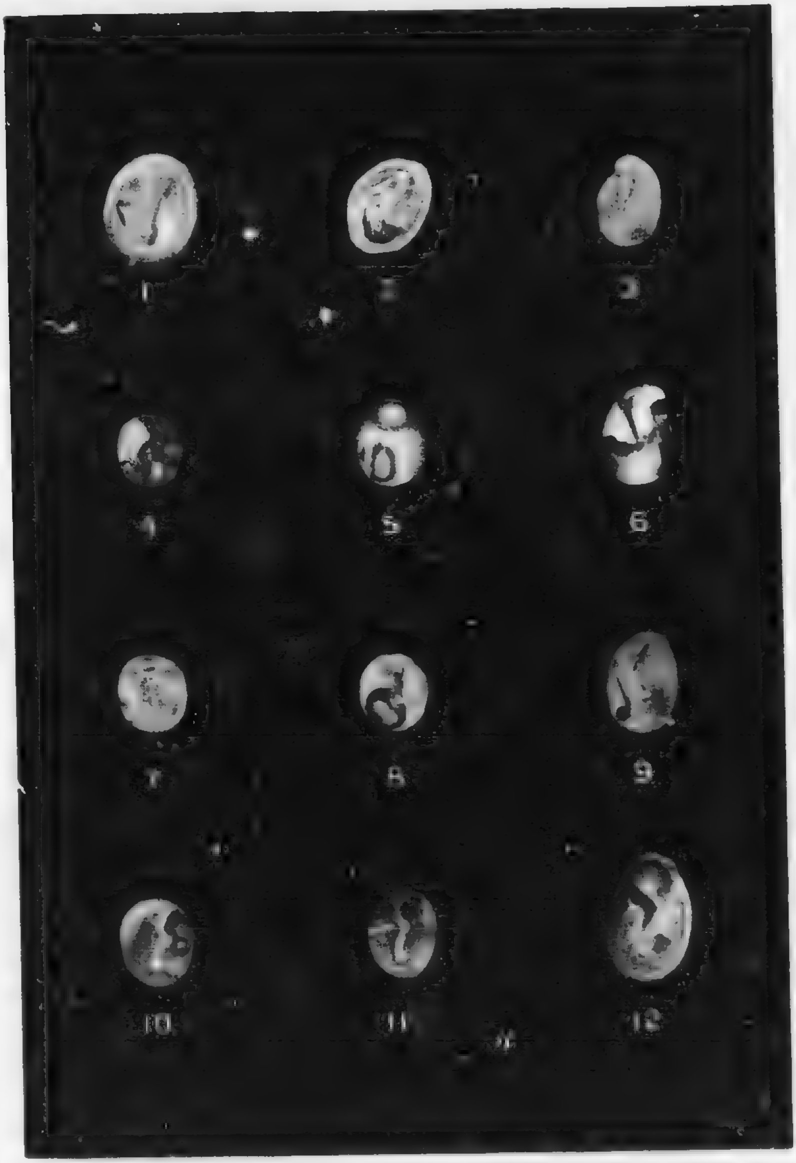
CHRONIC SUPPURATIVE CONDITIONS

1. Perforation in posterior superior, through which stapes and fenestra rotundum are visible ; anterior segment calcareous.
2. Perforation in inferior segment.
3. Cholesteatomatous concretion behind membrane at upper and back part ; due to old suppuration.
4. Granulations filling anterior segment of tympanic cavity.
5. Scar membrane, recent.
6. Destruction of inferior segment and also of posterior superior quadrant : head of stapes, stapedius tendon, fenestra rotundum, and promontory visible.
7. Perforation in posterior segment : stapes, stapedius tendon, and fenestra rotundum exposed.
8. Perforation in anterior inferior segment.
9. Perforation in posterior inferior segment : fenestra rotundum visible.
10. Perforation in Shrapnell's membrane, with small pendulous polypus hanging through.

11 and 12. Perforations in Shrapnell's membrane ; in 12, the remains of the head and neck of the malleus are seen.

[To follow Plate II.

PLATE III.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9. Right membrane : malleus drawn back and in, vertical and broken cone of light, central depression of membrane.

10 and 11. Pink reflex in case of otosclerosis : right behind malleus, left in the region of the foramen ovale.

12. Stria in membrane, cause undetermined.

To follow Plate III.

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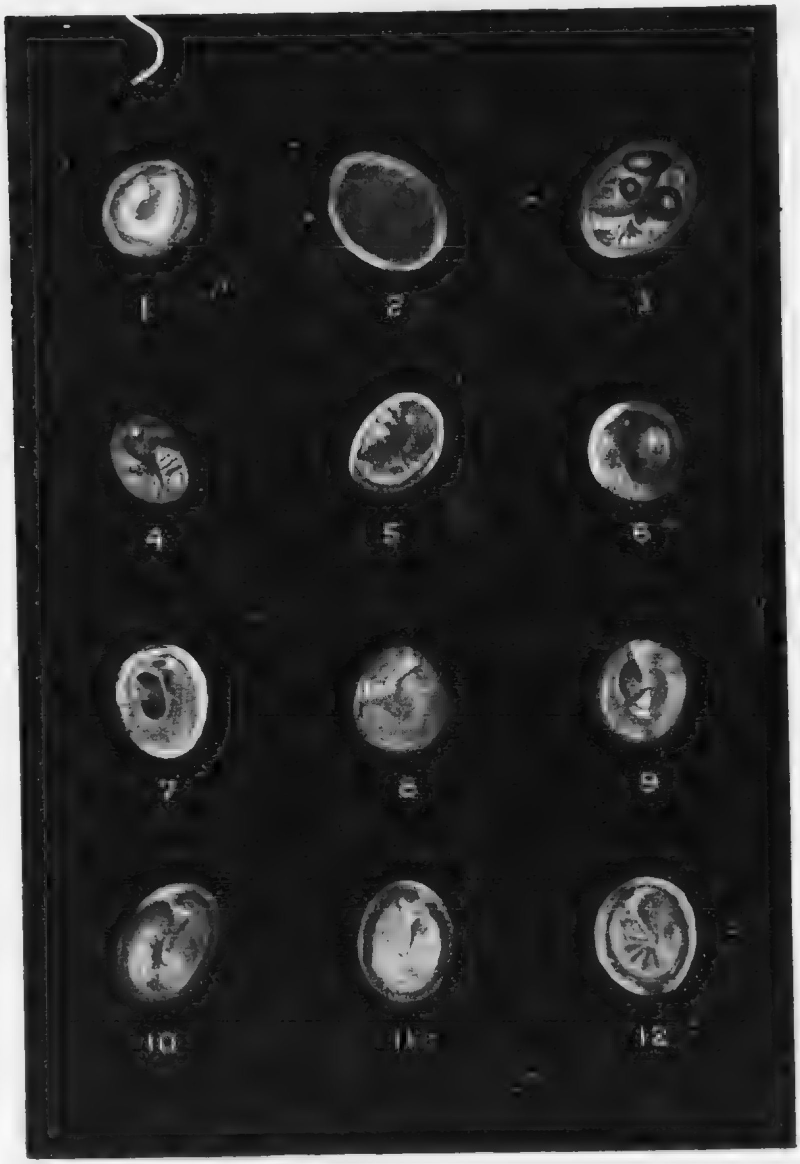
PLATE IV.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CHAPTER I

A BRIEF DESCRIPTION OF THE ANATOMY OF THE EAR

THE external ear, or pinna, is formed of fibro-cartilage covered by skin. This fibro-cartilage is thrown into folds of considerable irregularity in different individuals. These folds serve the purpose of catching and deflecting sound-waves towards the external meatus, and in part diminish the risk of insects finding their way into the external auditory meatus. The small portion of cartilage in front of the external meatus has for its principal function that of preventing the sound-waves thus deflected from being lost.

The pinna, as we have remarked, is covered with skin and subcutaneous tissues; and at its centre is folded upon itself; but the edges, although they come into close apposition, are not continuous, and a cleft is left at its upper part, the two edges being united only by fibrous tissue. The outer point of this cleft appears at the upper edge or surface of the tragus. A cartilaginous tube is thus formed, which is attached to the roughened surface of the outer part of the temporal bone, and forms the outermost portion of the external auditory canal, or meatus.

The external auditory meatus is a cartilaginous and bony tube about 1¼ inches long. Its external or cartilaginous portion is rather over ½ inch in length in the adult. The continuity of the cartilaginous tube is interrupted by two or three irregular vertical clefts, which are known as the fissures of Santorini. The inner or bony surface of the canal, which averages in the adult slightly over ½ inch in length, is continuous with the cartilaginous meatus, and is closed at its inner extremity by the tympanic membrane. The bony meatus itself is developed principally from the tympanic ring (Fig. 5).

The greatest diameter of the external auditory meatus is the vertical one. Taking the canal as a whole, it is at its narrowest at the external orifice, beyond which the tube immediately widens, to be again constricted a short distance beyond the junction of the cartilaginous and osseous portions. This portion, where the narrowing occurs, is termed the isthmus of the meatus and here the canal is distinctly smaller than at any other portion except at its outer extremity.

The general direction of the meatus is inwards and forwards. The floor is raised in the bony meatus, thus forming a general convexity of the floor upwards. The curvatures in the external meatus serve the purpose of diminishing the risks of damage to the inner ear which might otherwise occur from the direct impact of violent sound or air waves acting upon it through the chain of ossicles.

It is on account of this curvature of the meatus that, when one proceeds to an examination of the drum, or tympanic membrane, the pinna is drawn upwards and backwards, in order to make the canal sufficiently straight to obtain the necessary view of its innermost parts. This straightening of the meatus is possible by reason of the presence of the fissures of Santorini.

Immediately external to the drum, or tympanic membrane, the floor of the meatus dips downwards, forming a depression of variable depth, which is termed the sinus of the meatus. This depression in the floor of the meatus is of great practical importance, as it is not possible in all cases thoroughly to view the bottom of the sinus through an aural speculum, and small foreign bodies or insects may therefore occasionally lie therein undetected.

The walls of the external meatus are of unequal length, the floor and anterior walls being longer than the posterior and superior. This inequality results from the oblique position of the tympanic membrane, which does not occupy a plane at right angles to the general direction of the canal.

The external meatus is lined with skin, which is continuous with that of the pinna, and near its orifice are commonly found a number of hairs. These hairs are very fine in the young and the female, becoming coarser and longer as age advances; one observes a large number of small orifices opening into the external meatus, which are the mouths of the ceruminous glands. These glands, although chiefly situated in the cartilaginous meatus, are usually found sparsely scattered in that portion of the canal which we have referred to as the bony or osseous portion. The hairs serve to protect the tympanum by arresting the ingress of foreign bodies or insects; while the wax, or cerumen, which is secreted by the glands already alluded to, creates a slightly sticky surface, to which dust and small particles of matter adhere, and at the same time it binds together shed epithelial cells, which, together with the wax, are conveyed outwards by the movements of the lower jaw.

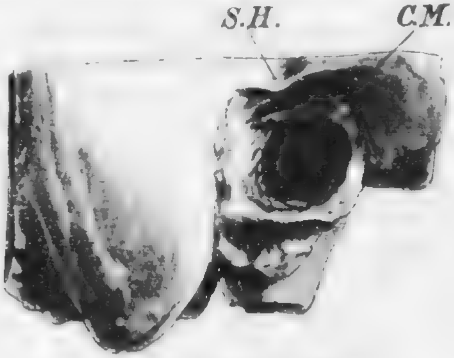


FIG. I.—RIGHT MASTOID.

SH, Posterior meatal spine, or spine of Henle; *CM*, cartilaginous meatus.

If the outer surface of the dried temporal bone be examined, there will usually be found at the upper and posterior part of the bony external auditory meatus a small spinous process, with a slight depression behind it (Fig. 1).

This spinous process is known as the spine of Henle, or the posterior superior meatal spine, and in the earlier days of aural surgery was considered a most important anatomical landmark with regard to operations on the mastoid antrum; whilst from the malar process of the temporal bone two ridges are observed running backwards, the superior of which should be remembered as forming a useful guide to the approximate upper limit for operative procedures on the mastoid antrum, unless it is desired to open the middle fossa of the skull. In some skulls the squamo-petrosal suture is visible, and the temporal bone may even remain divided in two parts at this suture, and when there is suppuration within the mastoid and such a suture exists, pus may always find an easy exit towards the surface.

The cavum tympani, tympanic cavity, or middle ear, is of an irregular shape, having measurements approximately

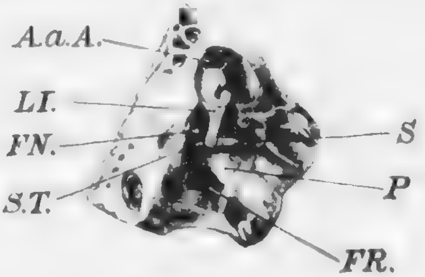


FIG. 2.—INNER WALL OF TYMPANUM (RIGHT).

AaA, Aditus ad antrum; *LI*, long process of incus; *FN*, Fallopian canal; *ST*, stapedius tendon; *S*, stapes; *P*, promontory; *FR*, fenestra rotunda.

¼ inch in depth, ¾ inch in height, and ½ inch in width. Its principal external boundary is the tympanic membrane, but the cavity extends in all directions beyond the membrane, but chiefly upwards towards the roof, forming the so-called attic. The upper wall, or roof, of the internal ear is formed by a thin layer of bone, which is termed the tegmen tympani. This bony plate is occasionally incompletely ossified, the spaces left in the bone being merely filled by fibrous tissue, so that in such instances there is between the middle ear itself and the dura mater only a thin layer of muco-periosteum, and through the deficiencies thus left septic matter in the middle ear may with relative ease find an entry into the middle fossa of the skull. The floor of the cavity is formed by a thin plate of bone, which at the same time forms the roof of that hollow in the lower portion of the temporal bone which receives the bulb of the internal jugular vein.

The anterior wall of the tympanic cavity is formed from above downwards by the following structures: Firstly, by a small piece of the temporal bone, in which an opening is occasionally observed, which passes directly into a series of cells in the petrous portion. These cells, when present, often extend to the very apex of the petrous bone. Next, one finds the bony wall of the carotid canal, below which is found the internal orifice of the Eustachian tube.

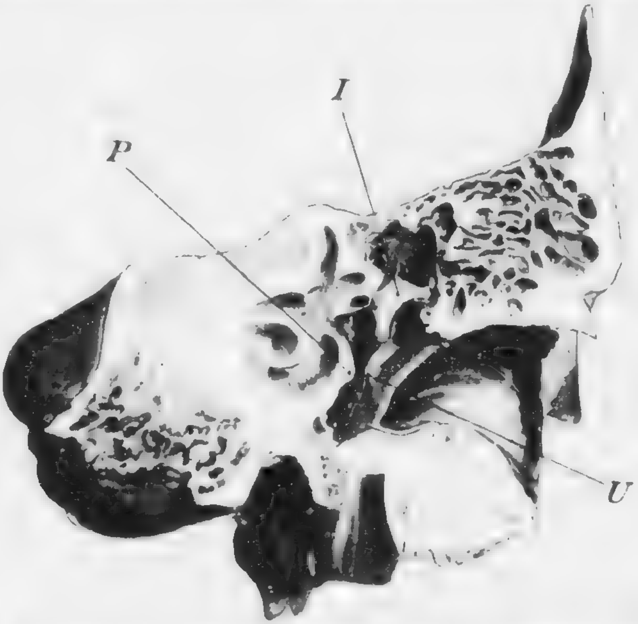


FIG. 3.—VERTICAL SECTION THROUGH RIGHT TEMPORAL BONE.
U, Umbo ; *I*, incus ; *P*, promontory.

The posterior wall of the cavity is formed first by the aditus, or the entrance into the mastoid antrum, and below simply by a portion of the temporal bone. Immediately below the aditus a small, hollow projection is observed, whence in life issues the tendon of the stapedius muscle.

The inner wall of the tympanic cavity is formed by numerous important structures (Fig. 2). A prominent ridge of bone is observed both above and behind, which runs half-way across the wall. This is the Fallopian canal, which in the recent state contains the facial nerve. Anteriorly to this one observes a small elevation, which is hollow, and perforated at its apex, through which in the recent state passes the tendon of the tensor tympani muscle. Below the Fallopian canal one observes an oval orifice—the fenestra ovalis—which in the living body receives the footplate of the smallest of the ossicles—the stapes—the edges of this footplate being connected with the surrounding bone by ligamentous tissue, and it is said that there is also present a tiny synovial sac. In the dried bone this oval opening communicates directly with the vestibule. At the lower and posterior part of the inner wall is another foramen, roughly triangular in form, known as the fenestra rotunda. Anteriorly to the fenestra rotunda, and below the fenestra ovalis, the internal wall of the tympanum projects prominently outwards, forming a rounded elevation, and to this elevation, which is formed by the first part of the lower coil of the cochlea, the title of the promontory has been given.

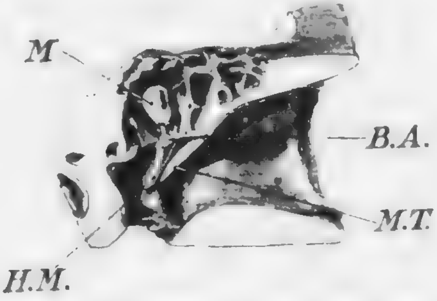


FIG. 4.—PREPARATION SHOWING ATTIC AND CAVUM TYMPANI.

MT, Tympanic membrane ; *HM*, handle of malleus ; *BA*, base of attic ; *M*, head of malleus, surrounded by irregular cellular spaces caused by reduplications of the mucosa.

The small pyramidal process from which the stapedius tendon issues may rarely be seen during life

The attic is that portion of the tympanic cavity which lies above an imaginary line drawn horizontally through the short process of the malleus, and which contains the head and neck of the malleus, together with the body of the short process of the incus.

The cellar is that portion of the tympanic cavity which lies at a lower level than the lower part of the external auditory meatus, and is very well shown in Fig. 3.

The whole of the inner surface of the tympanic cavity is closed in the recent state by a thick muco-periosteum, which periosteum is continuous on the upper side with the periosteum of the Eustachian tube, and on the other with that lining the larger accessory cavity of the tympanum, this being continuous, as will be seen later, with the fibrous portion of the tympanic membrane itself. The contents of the cavum tympani are the ossicles—viz., the malleus, incus and stapes, chorda tympani, tensor tympani, and the stapedius tendons, together with some small vessels and nerves.

The Internal Ear, or Labyrinth, is divided into two distinct portions—an anterior part, or cochlea, and a posterior part, the vestibule and semicircular canals. The former, which is supplied by the terminal fibres of the auditory nerve, forms itself the end organ, and it is this portion of the labyrinth which is entirely concerned with the conveyance of sound impressions to the brain. The latter, which is the end organ of the co-ordinating fibres of the eighth pair of cranial nerves, is concerned solely with the maintenance of the equilibrial functions.

These two portions, distinct though they are in function, are intimately connected by a junction of their lymph sacs, so that, unless that junction be permanently or temporarily interfered with, conditions of the endo- or peri-lymph involving the one portion must of necessity affect the other.

The membranous labyrinth itself is enclosed in a bony case of far greater density than any other bone, except that of the lower jaw, and is situated principally between the inner bony wall of the cavum tympani and the deeper portions of the temporal bone. The promontory, as we have mentioned before, is formed by the first turn of the cochlea, and the foramen ovale opens directly into the vestibule.

The membranous labyrinth itself consists of an outer fibrous covering, especially in its posterior part, which protects the inner or physiological portion of certain of the structures.

The external semicircular canal, which is the only one to be observed during operations on the mastoid, lies immediately above the Fallopian tube, which contains the facial nerve, and is plainly seen as an oval whitish projection on the inner surface of the aditus during the progress of the radical mastoid operation.

The posterior and superior canals are not exposed during most operations, but their relative positions are shown in Fig. 16.

A very important structure is the aqueduct of the vestibule, a fine fibrous tube connected with the endo-lymphatic sac, and which in the recent state has its extremity between the layers of the dura mater on the posterior surface of the petrous bone and anterior to the lateral sinus.

The whole of the labyrinth receives its blood-supply from one single artery, and this vessel after fœtal life has no anastomosis, from which it follows that any obstruction in or affecting this vessel must leave the internal ear without an efficient blood-supply.

For full details of the anatomy, histology, and physiology of the ear the reader is referred to the textbooks on anatomy and physiology.

The Ossicles.—The malleus, which is the largest of these little bones, is divided anatomically into a head, neck, and handle. The head articulates with the second largest bone, the incus. Below the head is a constricted portion—the neck—which passes into the long handle. At the junction of the handle with the neck are seen two processes of bone, one projecting outwards and forwards, known as the short process, or processus brevis; the other directed forwards and inwards towards—and in the fœtus through—the Glaserian fissure, the processus gracilis. The latter is represented in the adult by a minute point of bone, to which is attached the anterior ligament. The handle is directed nearly vertically downwards, and is intimately connected with the membrana tympani. The head of the malleus is attached to the roof of the tympanum by a ligament termed the suspensory ligament (Fig. 12). The incus consists of a body and two processes, the body articulating with the head of the malleus, to which it is united by a capsular ligament. The short process projects almost horizontally backwards, and articulates with the floor of the passage from the tympanum to the antrum. The long process descends parallel with the handle of the malleus to the level of the centre of the fenestra ovalis, where it articulates with the head of the stapes, to which it is attached by a capsular ligament. The third ossicle, or stapes, which closely resembles a stirrup, consists of a footplate, two crura, a neck, and a head. The footplate articulates with the inner edge of the fenestra ovalis, to which it is attached by an annular ligament. Of the crura, the anterior is straighter

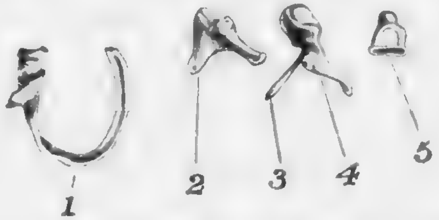


FIG. 5.—TYMPANIC RING, AND OSSICLES AT BIRTH.

1, Tympanic ring; 2, incus; 3, processus gracilis; 4, malleus; 5, stapes.

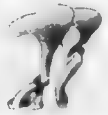


FIG. 6.—THE OSSICLES (RIGHT) ARTICULATED.

The stapes has fallen out of place; it should be almost at a right angle to the long process of the incus.

and shorter than the posterior. To the posterior part of the neck of the stapes is attached the tendon of the stapedius muscle. The footplate of the stapes moves hinge-like in the oval window, for on account of the greater laxness of the annular ligament in the anterior part its greater range of movement lies anteriorly. The chorda tympani nerve (Fig. 7) issues from the posterior wall of the tympanum, and crossing obliquely forwards, passes external to the long process of th

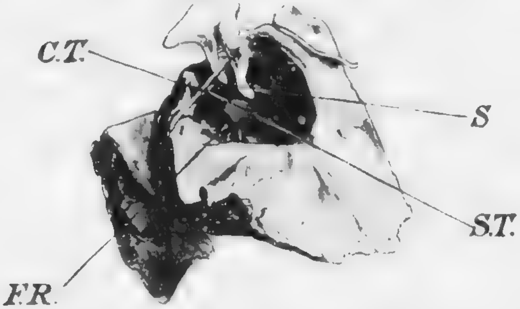


FIG. 7.—DISSECTION SHOWING THE RELATIONS OF THE CHORDA TYMPANI AND THE OSSICLES.

CT, Chorda tympani ; *S*, stapes ; *ST*, stapedius tendon ; *FR*, fenestra rotunda.

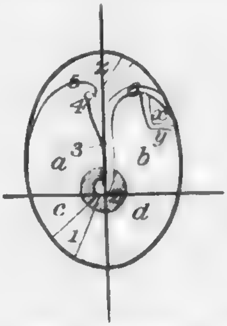


FIG. 8.—DIAGRAM OF THE TYMPANIC MEMBRANE, SHOWING VARIOUS NORMAL AND ARTIFICIAL POINTS.

1, Cone of light ; 2, umbo ; 3, handle of malleus ; 4, short process ; 5, anterior ligament of membrane ; 6, posterior ligament of membrane ; *a c*, anterior segment ; *a*, anterior superior quadrant ; *c*, anterior inferior quadrant ; *b d*, posterior segment ; *b*, posterior superior quadrant ; *d*, posterior inferior quadrant ; *z*, Shrapnell's membrane ; *y*, stapes ; *x*, long process of incus.

incus, internal to the handle of the malleus, above the tendon of the tensor tympani, and leaves the tympanum in company with the anterior ligament of the malleus by way of the Glaserian fissure. The ossicles, tendons, and chorda tympani nerve receive a covering of mucous membrane from the lining membrane of the cavity; this disposition of the mucous membrane forms irregular folds and bands within the cavity.

The Tympanic Membrane, or Drum, is a fibrous or periosteal membrane which, from the obliquity of the canal, faces downwards and forwards, forming an angle of 140° with the superior and posterior walls, and an acute angle of 30° with the anterior. Its general shape is oval, the longer diameter being the vertical one, and it presents a general concavity outwards. The handle of the malleus running almost directly downwards to the centre of the membrane, divides it into two unequal portions, the anterior of which is the larger. The concavity of the drum is deepest at the tip or free end of the handle. The centre of this small and deeply-depressed area has been styled the umbo.

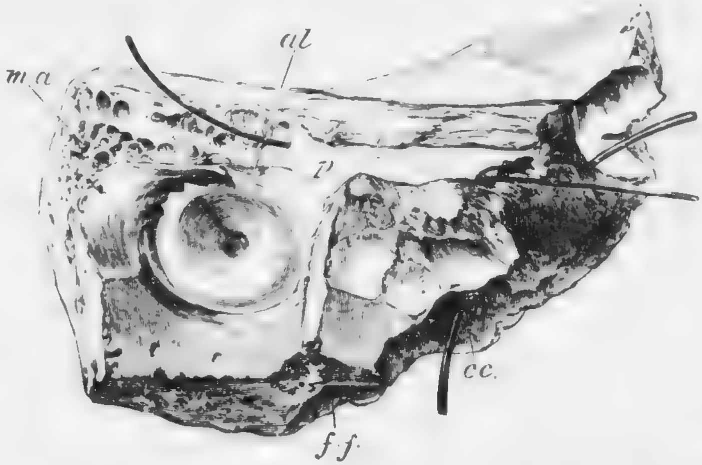


FIG. 9.—DISSECTION SHOWING THE PERIOSTEUM (*p*) OF THE EUSTACHIAN TUBE CONTINUOUS WITH MEMBRANA PROPRIA OF THE DRUM.

cc, Carotid canal (with probe); *fj*, jugular fossa; *al*, anterior ligament of malleus; *ma*, mastoid antrum. The second probe is in the Eustachian tube.

The membrana tympani itself consists of three layers—an external cutaneous, continuous with the skin of the external meatus, a middle layer of fibrous structure, and an internal layer of mucous membrane identical and continuous with that of the tympanic cavity. The middle layer, known as the membrana propria, has radiating and circular fibres, the radiating passing from the periosteum of the handle of the malleus to the periphery, while the circular are found only in the outer portion. The fibrous layer is inserted, as it were, into a firm ring of fibrous tissue, which is received into a bony groove at the inner extremity of the external meatus, termed the sulcus tympanicus. This groove is situated almost within the tympanic cavity, as seen in the dried bone. Through this fibrous groove the membrana propria is continuous with the periosteum of the external meatus on the one side (Fig. 9), and with that of the tympanic cavity and the Eustachian tube on the other (Figs. 9, 10, and 15). The handle of the malleus is intimately connected with the fibrous layer of the drum at its lowest part, but in its upper two-thirds the fibres of the drum for the most part pass external to it, thus per-

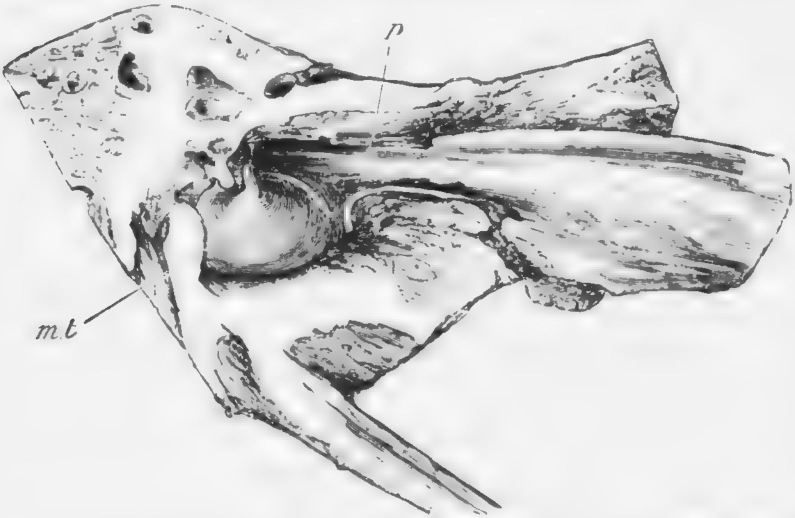


FIG. 10.—TYMPANIC MEMBRANE AND ANTERIOR HALF OF EUSTACHIAN TUBE, SHOWING THE PERIOSTEUM OF THE LATTER CONTINUOUS WITH THE SUBSTANCE OF THE FORMER.

mitting a certain amount of mobility of the posterior part of the drum without a corresponding movement on the part of the malleus. At the inner extremity of the external meatus the wall is deficient above. The space which is left is termed the notch of Rivini, and in the recent state is bridged over by irregularly interlacing bands of fibrous tissue. This portion of the drum forms Shrapnell's membrane, or the membrana flaccida, and is not actually part of the tympanic membrane proper.

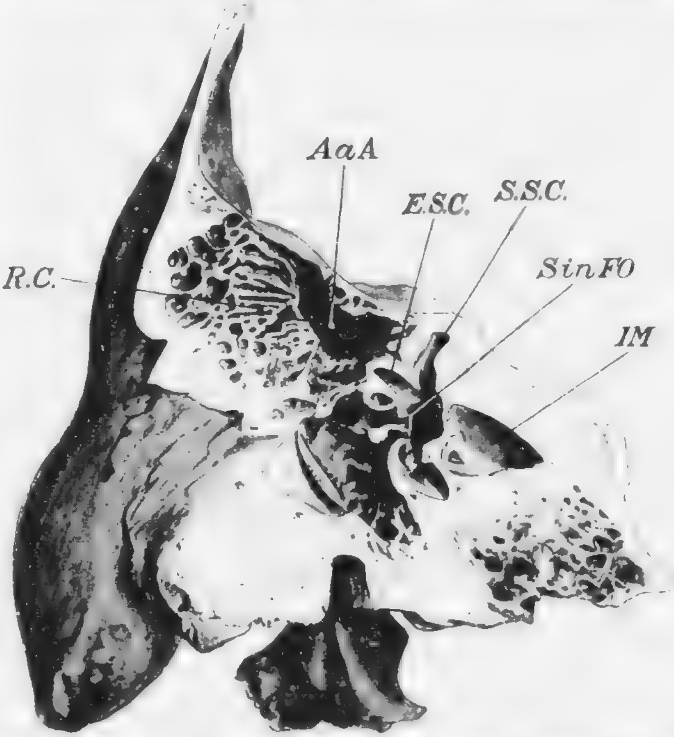


FIG. 11.—VERTICAL SECTION THROUGH RIGHT TEMPORAL BONE.

AaA, Aditus ad antrum ; *RC*, radiating cells (round antrum) ; *ESC*, external semicircular canal ; *SSC*, superior semicircular canal ; *S in FO*, stapes in fenestra ovalis ; *IM*, internal meatus.

The tympanic membrane is divided, for purposes of description, by an imaginary line drawn through and in continuity with the handle of the malleus, into an anterior and posterior segment. These segments are subdivided by a line drawn at right angles to the former through the tip of the malleus, thus dividing each segment into two, which are known respectively as the anterior superior, anterior inferior, posterior inferior, and posterior superior quadrants (Fig. 8).

Besides the handle of the malleus, the following features are to be observed by inspection of the drum:

In appearance, the membrane is in health pearly grey, but considerable variations are observed within physiological limits. At the upper part of the handle, projecting forwards and outwards, is a small bony process. This is the processus brevis, or short process of the malleus, which in the healthy subject appears white. Above this point lies Shrapnell's membrane, while from it run two curved bands with their concavities downwards, the anterior and posterior ligaments of the membrane, which form the upper margin of the drum, and limit Shrapnell's membrane below. There is seen spreading forwards and downwards triangularly from the umbo a light reflex, called the cone of light, which owes its origin to

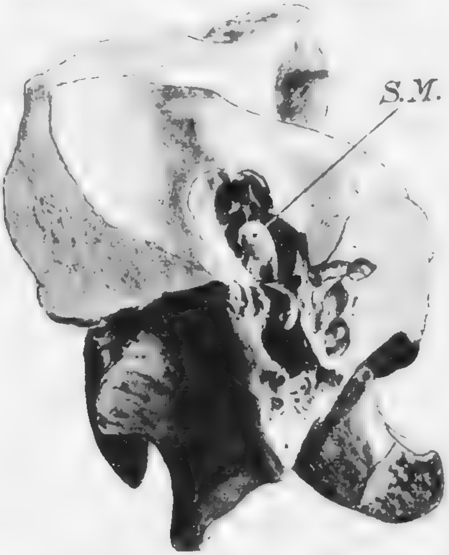


FIG. 12.—TEGMENTUM TYMPANI REMOVED, EXPOSING MALLEUS AND SUSPENSORY LIGAMENT (*SM*).

the peculiar concavity of the normal drum, for light can only be reflected back to the observer from this small triangular area of the drum ; its extent should be from the umbo almost to the periphery.

The Antrum, also called the mastoid or tympanic antrum, is the most regular of the pneumatic or air cells found in the mastoid process. It is situated posterior to and at a slightly higher level than the main cavity of the tympanum, with which it is connected by a passage, the iter, or aditus ad antrum. It is formed in the fœtus by the junction of the squamous and petrous portions of the temporal bone, and exists before the mastoid process is developed. Its size in the fœtus and child is proportionately very large. And, excepting from its situation in the adult, the term 'mastoid antrum' is not anatomically correct. The aditus, or passage into the antrum, opens into the tympanic cavity at the upper part of its posterior wall, the facial nerve passes from before backwards at the tympanic end of its floor, and the external, or horizontal semicircular, canal makes a projection forwards

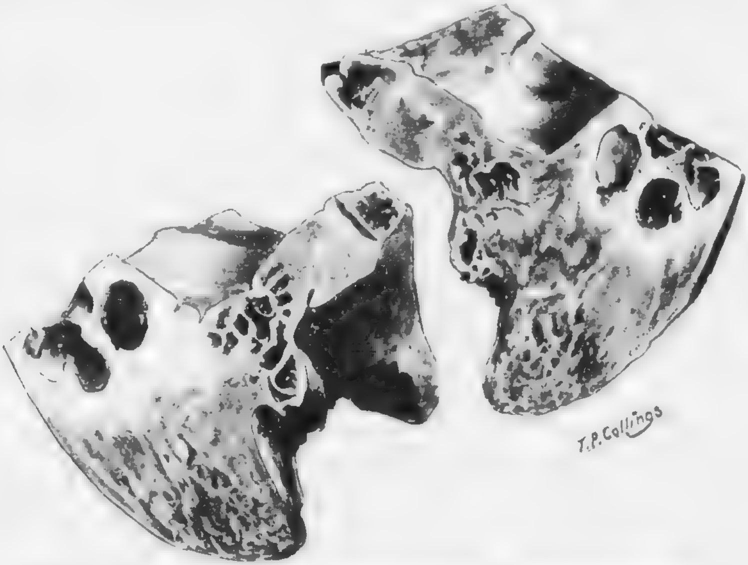


FIG. 13.—SECTION THROUGH SCLEROSED MASTOID PROCESS.

on its inner wall. The antrum in the fœtus is situated superior, but on a slightly posterior plane, to the tympanic cavity; but at the end of childhood, about the age of nine years, it has come to occupy relatively the same level at which we find it in the adult. The antrum is connected with the other pneumatic cells of the mastoid process. There are, in addition to the antrum, two groups of these cells, which are of importance on account of their position, one being situated at the inner part of the root of the external meatus, termed the 'border cells,' which, if not connected directly with the

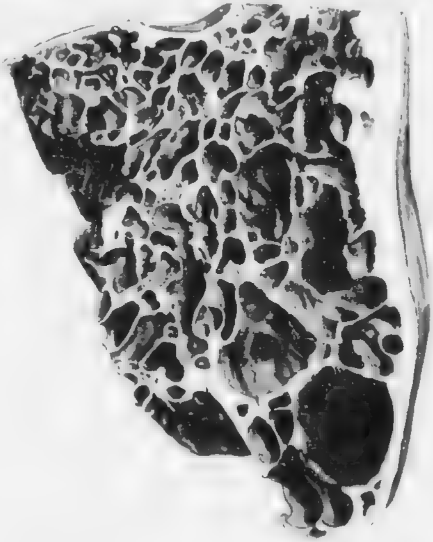


FIG. 14.—CELLULAR MASTOID PROCESS.

attic, are connected with the antrum; the other group, when present, extends upwards and forwards from its posterior root into the base of the zygomatic process. The orifice of the aditus is in a direct line with the tympanic orifice of the Eustachian tube; so that if a probe be passed up the Eustachian tube, after crossing the tympanic cavity it strikes and enters the aditus. From this it will be seen that the antrum is not situated at the same level as the tympanum itself, and it is of great importance to remember this fact when performing the radical operation of mastoidectomy as the inner wall of the tympanic cavity appears to, and does, lay at a greater depth from the surface than the inner wall of the antrum lies. The uses of the antrum and air cells are partly to lighten the skull, and partly to act as an air cushion to lessen concussion from loud noises or explosions. The outer wall of the antrum is placed about 0·6 inch from the surface, and is separated from the sigmoid groove by about 0·48 inch.

The Eustachian Tube is 1½ inches long, is directed downwards, forwards, and inwards, and, like the external meatus, consists of a bony inner portion, approximately ½ inch in length, and an outer cartilaginous portion. The narrowest part of the Eustachian tube is at the junction of the two parts, and is termed the isthmus. The cartilaginous canal opens into the naso-pharynx at a level slightly above that of the hard palate. The posterior part of the cartilaginous wall projects inwards, forming an eminence termed the posterior lip of the ostium. Just within this orifice, and beneath some involuntary muscular fibres, is normally found a small quantity of fat, which assists in keeping the sides of the tube in apposition. The tube itself is lined with ciliated epithelium. Behind the ostium is a deep depression in the side of the naso-

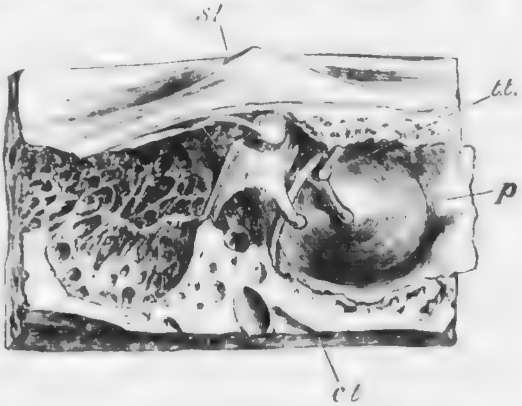


FIG. 15.—SECTION (VERTICAL) PASSING THROUGH THE CAVUM TYMPANI AND ANTRUM, SHOWING THE TWO LARGER OSSICLES IN SITU.

ct, Chorda tympani ; *tt*, tensor tympani ; *sl*, suspensory ligament of malleus ; *p*, periosteum of Eustachian tube.

pharynx, termed the fossa of Rosenmüller. into which the Eustachian catheter may be passed in mistake for the entrance of the Eustachian tube. The tube itself is opened during the process of deglutition, which enables the air within the cavum tympani to maintain an equal pressure with that of the atmosphere; and it is upon a knowledge of this physiological fact that the process of inflating the tympanum, which goes by the name of politzerization, is founded.

The Mastoid Process is not present at birth, and does not acquire its typical shape until the end of the third year. In the adult it varies much in structure, but its general shape is much the same, being roughly triangular, with the apex downwards. It contains, besides the antrum, certain irregularly distributed pneumatic cells, together with a certain amount of diploë. The structure of the mastoid may vary within wide limits, being, on the one hand, composed entirely of cells (Fig. 13), and, on the other hand, formed almost entirely of dense bone (Fig. 14). When the mastoid process

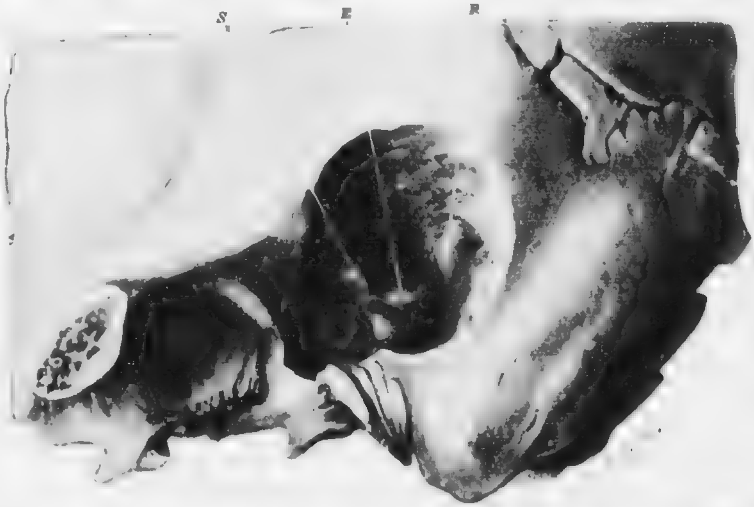


FIG. 16.—DISSECTION OF SEMICIRCULAR CANALS, SHOWING THEIR RELATIVE POSITIONS.

S, Superior; *E*, external; *P*, posterior (a hole has been out with the cochlea).

is formed almost exclusively of cells, the majority are pneumatic ; and in these instances there is one cell which is fairly constantly present, and is found at the lower and inner aspect of the mastoid process just above the groove for the digastric muscle. To the presence of this cell is due the fact that, in certain inflammatory conditions of the mastoid, pus is enabled to find its way into the digastric groove, and onwards into the deep structure of the neck. At other times the general structure of the process resembles that of the diploë.

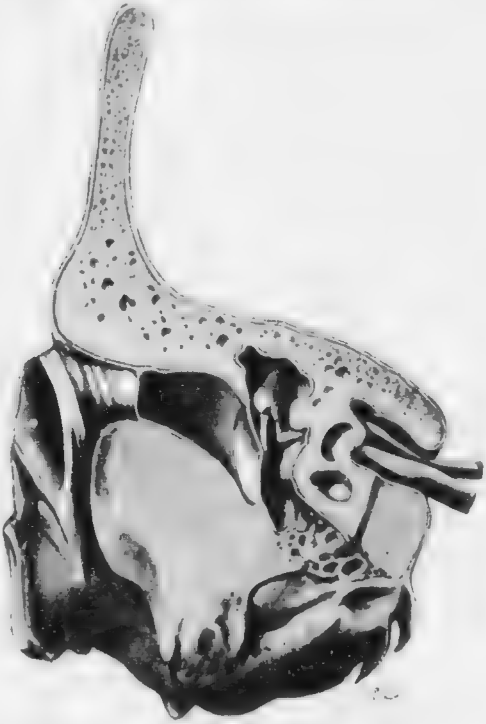


FIG. 17.—SECTION OF TEMPORAL BONE CUT THROUGH INTERNAL AUDITORY MEATUS.

CHAPTER II

THE GENERAL EXAMINATION OF THE PATIENT

The Patient's Previous History.

INQUIRY should be first directed to the family history of the patient and to his previous illnesses, more especially with regard to the various exanthemata, and any relationship suggested by the patient between the first occurrence of the aural trouble and any such general disorder made note of. In the event of no such information being forthcoming, careful cross-examination, with reference particularly to scarlet fever and measles and the first onset of deafness or discharge from the ear, will often throw a good deal of light on the nature and duration of the disease. Inquiry should also be made as to whether the patient in childhood had been subject to attacks of earache, for cases will not infrequently present themselves in which there is more or less destruction of one or both tympanic membranes, or other strong evidence of previous aural suppuration, and yet the patients deny any knowledge of discharge from the ear, but distinctly remember that they frequently had earache in early childhood, the presence of the discharge having been either overlooked by them and their parents or completely forgotten. Nor must the occurrence of frequent colds and relaxed or sore throats be passed by, as these are a common predisposing cause of non-suppurating otitis media.

If there is deaf-mutism, it is very important, from the point of view of prognosis, that the earliest sign of the deficiency be accurately determined, such as whether the child had ever shown any signs of hearing or uttered any articulate cry, or whether the child had already commenced to speak, if only one or two words, and that after some severe illness or accident the hearing power was lost, and with it that of articulate speech. Cases of deaf-mutism subsequent to disease in early childhood require to be divided with great care into those dependent on intracranial or labyrinthine lesions, such as those following meningitis, and into those due to a probable special inflammatory condition of the middle ear, causing temporary deafness. A frequent origin of this latter form is secondary involvement of the middle ear during an attack of broncho-pneumonia. In these cases, when the child has been thought to have suffered from meningitis, even if some of the serious symptoms of meningitis have been present, the aural prognosis is much more hopeful than in those cases due to genuine meningeal trouble.

Previous Illnesses, it is necessary to bear in mind, often have a distinct influence on the ear, particularly should the presence or absence of hereditary or acquired syphilis be ascertained. When this disease is hereditary, and deafness presents itself as a tertiary lesion, it usually begins in early life, from the age of twelve upwards, but it may be delayed until young adult life. It generally commences after the appearance of interstitial keratitis. It is rapid in its course, and the influence of the treatment adapted to the keratitis apparently affects the course of the aural disease only slightly. Hutchinson's teeth and any affections of the nasal bones, as well as a history of snuffles, must be searched for.

Gout, Rheumatism, each have an effect upon the ear in a certain proportion of cases. The most frequent manifestation of gout is to be found in an eczematous condition of the external meatus; in cases of chronic middle-ear catarrh the tendency to tinnitus and vertigo is greatly increased if the patient has a gouty dyscrasia.

In rheumatism the remedies administered for its cure will frequently cause tinnitus and deafness, the most important of these being the salicylates; and it has been noticed that where they cause aural trouble there is already a tendency to diseases of the ear.

Arterio-Sclerosis.—This disease frequently affects the in ternal ear, and is a prolific cause of deafness, vertigo, and tinnitus.

Influenza may be followed by hæmorrhagic otitis media, by suppurative otitis media, and by isolated abscess in the mastoid, and these in turn may give rise to any of the intracranial lesions which follow on suppurative disease of the middle ear. In other cases non-suppurative catarrh may be set up, or severe nerve-deafness itself may follow.

Residence in the Tropics, especially if the patient be also subject to attacks of malarial fever, is often found to have an important bearing on the progress of the non-suppurative diseases of the middle and inner ear. It also has a tendency towards the production of an altered secretion of the ceruminous glands of the external ear, causing an undue accumulation of cerumen. Ague, which in England is now certainly very rare, but is still to be found, especially in the Fen Country and in the low-lying lands of Kent and Essex, has an equally deleterious effect upon the ear to that which malaria has in the tropics.

Hysteria and Neurasthenia.—In patients affected with either of these ailments, marked deafness of a more or less sudden character not infrequently occurs. In every such instance a careful examination will prove that there really exists some slight form of aural trouble.

Climate is also indirectly responsible for much aural disease, too much moisture in the atmosphere inducing catarrhal states of the nose and naso-pharynx, thus indirectly affecting the ear through extension of the inflammatory processes up the Eustachian tube. The inhabitants of the basins of rivers and fen-lands and those living on clayey soils are much more likely to suffer from adenoids than those living in higher and dryer localities. These vegetations lead to diminished aeration of the ear, as well as catarrhal changes, and expose the individual to a greater liability to inflammatory processes in the middle ear.

Unhygienic Surroundings and faulty nutrition appear to have only an indirect effect on the ear, but it is of interest to remember that atrophic rhinitis is chiefly met with in those classes exposed to bad environment, and of these cases a proportion is complicated with ear disease.

Habits and Occupation must be also considered as to their influence on the individual. Any tendency to excess in the consumption of alcohol or of tobacco, though rarely of themselves likely to be the primary cause of an aural complaint, may certainly be the means of accentuating it, if present. Those occupations where workmen are employed in tunnelling predispose to ear affections, if it be necessary, under such conditions, to use chambers of compressed air in caissons. In the case of workers in compressed air there is reason to believe that if due precautions are taken no evil effects accrue so long as the individual subjected to the increased atmospheric pressure has a relatively normal ear, including a patent Eustachian tube and an unobstructed nose. Riveters, who are exposed to almost continuously repeated sounds of more or less one pitch, are especially liable to aural complaints; and with men similarly employed the continuous clang of the metal causes a severe and intractable variety of nerve-deafness, and this does not appear to be entirely dependent upon previous slight aural disease, though middle-ear deafness doubtless predisposes to it. The same effect is often found in shooters, and also in naval and military men. Ordinary commercial life cannot be said to cause deafness, but great mental strain and prolonged anxiety will materially exaggerate any existing middle-ear deafness. This effect naturally depends largely on the temperament of the individual.

Injuries.—Certain injuries act directly on the tympanic membrane, causing rupture of the drum. Of these, direct blows on the ear, by compressing the air in the external meatus, are the commonest causes. Sudden compression of the air, such as that caused by loud explosions, in the near vicinity of the patient has been known to cause a like result, but it is supposed by most authorities that this would not have occurred had the drum been normal, though this opinion has been ably contested. The membrane is sometimes injured by patients attempting to remove wax by the help of hairpins, etc., which are inadvertently thrust through the membrane, an accident which has happened to surgeons in ill-directed attempts to remove a foreign body without proper illumination of the meatus.

The internal ear may also be similarly injured by the effects of concussion, the most frequent causes being loud noises close to the ear, such as are produced by the firing of large ordnance when the individual is standing near to, and on a level with or slightly beyond and to the side of, the mouth of the piece. Fracture of the base of the skull, if the fracture passes through the labyrinth, will cause deafness, but notwithstanding this, loud subjective noises may afterwards be a distressing feature in the case; concussion of the brain and severe blows on the mastoid may cause deafness through concussion of the labyrinth.

The Patient's Present State.

The next step in the examination of the patient consists in making a careful survey of his present condition.

The Aspect of the Patient.—From the patient's appearance valuable information is obtained. Should the patient be young, and there is reason (there usually is in aural patients at this period of life) to suspect the presence of adenoid vegetations, the facial aspect must be noted. There are two physiognomies associated with nasal obstruction in children. In the one there is a sleepy and often vacant look, which, in its most pronounced type, denotes the so-called aprosexia of Guye. Here the expression lacks intelligence, the mouth is open, the eyes wide apart, the bridge of the nose broad and low, with frequently a vein running transversely across it; these patients have great difficulty in concentrating the attention and maintaining it fixed on any special subject. In the other class the nose is narrow and pinched, the alæ collapsed, and the mouth open. Between these extremes any intermediate condition may be met with, but the mouth is always open at night. The patients, with few exceptions, snore, though the mouth may not be noticeably open during the daytime. The palate is generally highly arched, often irregularly so, and the alveolar arch is contracted anteriorly; the front teeth project outwards, and not uncommonly the inferior maxilla is, as a whole, badly developed, so that the lower incisors come into contact with the posterior surface of the upper set, which in consequence often assume a more or less horizontal direction. The faucial tonsils may or may not be enlarged; should there be nasal obstruction, a resulting granular pharyngitis will always be present.

In adults the tendency to mouth-breathing should be carefully observed, and the state of the patient's lips will often afford a clue, as in mouth-breathers the muco-cutaneous surface of the lower lip is dryer than in nose-breathers; patients will often deny that they are mouth-breathers, when it is quite evident that during intervals of speaking their lips have been obviously apart. As corroborative evidence of mouth-breathing in children, besides snoring, there is great restlessness during sleep, night terrors, and complaints of thirst during the night; in adults, the patient, on waking in the morning has often either a dry tongue or a disagreeable taste in the mouth.

Facial paralysis, if present even to the slightest extent, will be easily remarked. Any tendency on the part of the patient to look at the mouth of the examiner should be observed; to detect this habit it is a good plan to practise speaking with as little lip movement as possible.

From the patient's voice there is also something to be learned. The dead and so-called nasal voice of adenoids and obstruction is easily recognized and never forgotten. Neither is the inability which accompanies this condition to pronounce distinctly certain letters, M especially. Patients with chronic non-suppurative disease of the middle ear, even when they are suffering from a severe degree of deafness, usually speak in a quite low tone, whilst elderly people, whose deafness is largely attributable to old age, not infrequently shout. Sufferers from nerve-deafness have in most cases a dull, monotonous delivery. Malformations of the ear, unequal projections of the auricles, the presence of new growth, and disfigurements from old othæmatomata, will be observed on superficial examination.

The Patient's Present History and the Duration of the Disease.

The length of time that the patient has suffered from hardness of hearing, tinnitus, or discharge, should be carefully inquired into, and leading questions will often cause him to considerably antedate his original statements. The importance of this history in non-suppurative diseases of the middle ear lies in the influence it has upon prognosis. In acute suppurative disease of the ear the patient will give a much more correct history than if it is chronic and dates from early childhood; in all suppurative conditions, however, the presence of pain, headache, local neuralgias, giddiness, sickness, nausea, or facial paralysis, as well as definite cerebral symptoms, such as loss of memory, especially for names and places, should be most carefully inquired for. In non-suppurative affections questions should be directed towards the presence or absence of adenoids, nasal obstruction, complaints of giddiness and pain, as well as whether or not the patients hear their own voices better than extraneous sounds, and, finally, whether hearing is better during noise than in quiet. The urine should be examined for albumin or sugar, the former especially in cases of tinnitus, the latter in acute mastoid abscess; and in elderly patients the condition of the bloodvessels is of great importance.

THE SPECIAL EXAMINATION OF THE PATIENT

In all cases of ear trouble, after the patient's history has been completed, the ears should be examined before proceeding to test the powers of hearing. For, should the meatus be blocked by a ceruminous plug, any examination with the tuning-fork would be useless.

In the examination of the ear the head-mirror should be invariably used. For convenience the ordinary rhino-laryngological mirror with a focus of 8 inches is used, but for finer work, and to obtain a more definite detailed view, a mirror having a focus of about 4½ inches will be found superior. It is better, especially in towns, to use artificial light, but, when available, sunlight reflected from a white cloud supplies serviceable illumination. In order to obtain greater detail a convex lens may be used, either attached to the mirror or to the speculum.

The external ear is rapidly examined with the eye, as well as with the finger and thumb, to detect any thickening or abnormal condition of the pinna. The entrance of the meatus, its size, as well as any obvious obstruction or the existence of discharge, must be reviewed. If there is discharge or pain complained of, the surface of the mastoid process should be palpated, and at the same time any tendency to redness or puffiness of the skin in this region looked for, as well as any obliteration of the post-auricular cleft ; the relative projection of the auricle, as compared with its fellow, is an important sign. After gentle palpation, firm pressure should be made over the whole mastoid process, especially over the site of the mastoid antrum—that is to say, a spot close behind the auricle, and at a slightly higher level than the external meatus. The elicitation of pain here or at any other portion of the mastoid may be considered periosteal in origin if the pressure required is slight, but due to disease within the bone if the pressure required be firm. Again, in periosteal trouble tenderness will be general rather than local. The presence also of any subcutaneous collection of fluid, of an enlarged gland, or discharging sinuses in this locality, cannot be missed if this scheme of examination be carried out.

Having now obtained all the information possible by these means, a careful examination is made of the meatus and tympanic membrane through a speculum. A form of speculum which is entirely satisfactory is that of Grüber. It is made of metal, blackened on the inside, and is elliptical in section. The speculum chosen should be the largest which will enter the meatus easily, and in cold weather it is better slightly to warm the instrument. In introducing the speculum, the pinna is taken between the finger and thumb and drawn gently backwards, outwards, and upwards, thus straightening the meatus and enabling the observer to obtain the best possible view of its interior and of the tympanic membrane

Having inserted the speculum, the following points are to be observed: Any obstruction of the canal, whether this be due to substances within it, as accumulated cerumen, or caused by a projection of the meatal wall, as by abscess, exostosis, or new growth; whether the obstruction be due to contraction of its lumen, either cicatricial or otherwise. The colour of the normal meatus is that of ordinary skin, and any variation therefrom should be noted: if it be red from inflammation, ulcerated, as occasionally happens in secondary syphilis, or if it be unusually smooth, white, and glistening, as in otosclerosis, or whether its surface exhibits spots of a black, slate, red, or white tint due to the presence of fungi. The existence of discharge, or a dry and scaly condition of its walls, must not be missed. If the lumen of the meatus is not absolutely

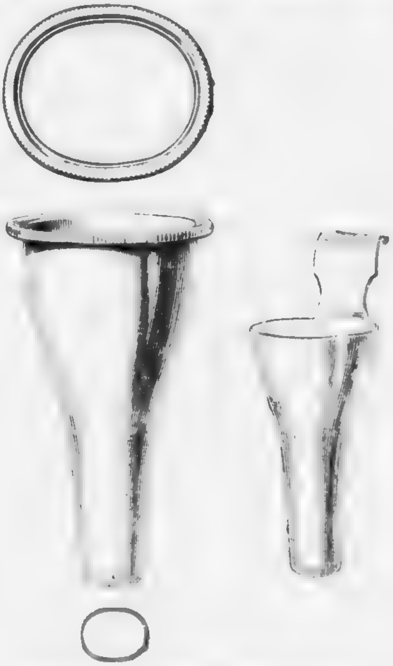


FIG. 18.—AURAL SPECULUM.

The left-hand woodcut represents the largest-sized Grüber's speculum, with a view of the two extremities, showing their ovoid form. The woodcut on the right is a Gruber's speculum cut down to enable the surgeon to operate more easily on the drum.

free from obstruction, steps must be taken to render it so, as well as to remove every trace of discharge or moisture before proceeding to an examination of the fundus. The tympanic membrane is first observed with the patient's head erect, and afterwards with the head inclined towards the opposite shoulder, in order to enable the upper part of the drum, together with Shrapnell's membrane and the meatal roof, to come into view.

It cannot be too firmly impressed upon students of aural surgery that, under no condition whatever, should an examination of the tympanic membrane be carried out so long as there is the slightest trace of moisture within the canal. Indeed, an opinion ought not even to be formed, until all moisture has been removed from the ear, though such cleansing is chiefly necessary in suppurative conditions. The presence of offensive pus would usually justify the assumption that the drum was perforated; but it is not until the ear has been thoroughly cleansed and dried that the actual state of the fundus can be accurately determined, even by the most experienced aurist.

The inner extremity of the external meatus is normally closed by the membrana tympani, which is placed with its outer surface looking both downwards and outwards; it is this obliquity which enables the skilled examiner to estimate any alterations in the general contour of the drum. In some instances the external meatus is so straight, and its calibre so large, that a fair view of the membrane may be obtained without the use of the speculum and reflected light. In others the meatus is so small, and its natural curves so exaggerated, that only a part of the membrane can be viewed, even by the most skilled. (For description of the membrane, see *ante*.)

The attention should now be directed towards observing the colour, transparency, and general characteristics of the drum; the direction and apparent shape of the handle of the malleus; the direction, size, shape, and integrity or otherwise of the cone of light. Alteration and variation in the cone of light is one of the most usual phenomena, and normal hearing may be found when the cone is abnormally situated, more especially in the young. The reason that with the normal drum the cone does not reach to the periphery is on account of the change of the curvature of the membrane. With a considerable central depression of the drum the cone shortens, broadens, and often divides in its long axis. With less indrawing the changes are of the same character; but are less marked with posterior displacement of the malleus. With rotation of the bone backwards the reflex becomes horizontal, and consequently shorter, and is divided in many instances.

Occasionally a light reflex is to be noticed behind the handle of the malleus, and close to the posterior fold of the membrane. This is of an irregular shape, and irregular in situation, and it signifies an undue laxness of the posterior part of the tympanic membrane. That is to say, the membrane in this situation has become stretched in its upper and posterior portions, that being the part where the current of air forced up the Eustachian tube impinges most directly on the tympanic membrane.

The examiner should also search for perforations or depressions in the tympanic membrane. A depression can usually be detected, or distinguished from a perforation, by the fact that, except in the very smallest of them, a light reflex may be seen somewhere in its depths, caused by the reflection of light from the indrawn portion of the drum, whereas in a perforation one never gets a light reflex unless the perforation be extremely large, and a small amount of light may be then reflected from a dry promontory bared of mucous membrane.

Calcareous patches and patches of local thickening, or attenuated areas in the drum, also demand attention, as well as any swelling or bulging of the membrane. The latter condition is to be looked for with special care in the posterior segment; in inflammatory diseases any bulging of the posterior superior meatal wall adjacent to the membrane is very significant of suppuration in the antrum. In non-suppurative conditions any particular prominence of the posterior fold of the membrane must be looked for; in elderly people the existence of a circular peripheral opacity resembling the arcus senilis will frequently be observed. When no perforation is present, and deafness is the prominent symptom, the mobility of the various parts of the membrane and of the handle of the malleus should be ascertained by the use of Siegle's speculum. Indeed, the importance of an intelligent use of the pneumatic, or Siegle's, speculum in all cases of non-suppurative disease of the middle ear cannot be overestimated, and is never to be omitted. At this period of the examination it is well to proceed to investigate the nose, naso-pharynx, and pharynx, while the patient is still in a good position with regard to the light.

Examination of the Nose and Naso-Pharynx.

An examination of the ear should invariably be accompanied by a systematic examination of the nose and naso-pharynx. The importance of this has long been recognized, especially in those aural diseases incident to childhood, which largely depend for their origin on conditions connected with the presence of adenoid vegetations in the naso-pharynx. It was Toynbee who first described these growths under the name 'thickened membrane causing obstruction of the faucial orifice of the Eustachian tube,' to which he was in the habit of applying nitrate of silver with a curved porte-caustique. Besides this abnormal state there are numerous morbid conditions in the nose and naso-pharynx which are responsible for secondary pathological processes in the ear; unfortunately, in a large majority of cases treatment directed to the removal or correction of abnormal conditions in the nose and naso-pharynx will not be attended with any marked improvement in the hearing power on account of the duration of the aural complaint, which has resulted in permanent injury of the ear itself. This failure is apart, however, from any comfort accruing to the patient from careful attention to the nasal trouble; nevertheless, by local treatment of this kind it is possible to retard the progress of the disease in the ear. From a pathological standpoint it is possible to obtain from the nasal condition valuable information which may assist in determining the origin of aural complaints.

The examination in question consists in the inspection of the nasal chambers from the front, a procedure known as anterior rhinoscopy; from behind, the naso-pharynx and posterior choanæ may be indirectly viewed, a method known as posterior rhinoscopy. In order to inspect the nose from the front, reflected light is directed by means of a forehead mirror into the anterior nares, the alæ of which are held apart by means of one of the various forms of nasal specula, Thudichum's being one of the most convenient. At the commencement of the examination the head should be kept perfectly upright, the tip of the nose being elevated by the examiner. In this posture the lower part of the septum and the front portion of the inferior turbinate body can be examined. Theoretically, the septum should be perfectly upright as well as straight antero-posteriorly, and the inferior turbinate body should be separated from it by an appreciable distance, on an average $\frac{1}{10}$ inch. The lower edge of the inferior turbinate should also be separated from the floor of the nose by an interval of about $\frac{1}{12}$ to $\frac{1}{8}$ inch for its whole length. The septal mucous membrane has a yellowish-pink hue, whilst that of the inferior turbinate is pink in colour.

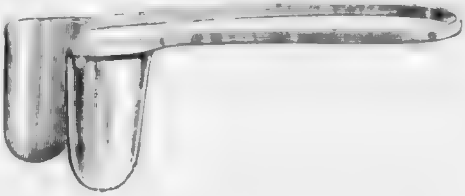


FIG. 19.—THUDICHUM'S NASAL SPECULUM.

The abnormal conditions frequently found in the nose are irregularities in the direction of the septum, as deflections from the perpendicular plane and localized projections, the latter being commonly known as crests or spurs. The abnormal states of the turbinate are usually evidenced either by an increase or diminution in size. The increase in size of an inferior turbinate is greatest when the septum is deflected towards the opposite cavity; in these cases the bone, as well as its mucous covering, will often be hypertrophied; the diminution in size is most marked in advanced cases of the disease known as atrophic rhinitis—in fact, the bone may be completely absorbed with the exception of the superior part of the anterior extremity. The nasal cavity then appears very large and roomy, and is usually filled with offensive crusts, the removal of which frequently enables the examiner to observe the orifice of the Eustachian tube and the superior edge of the posterior choana.

From the point of view of the aurist, the most important divisions of the nose are the inferior and middle meatus, for it is in any interference with the current of air normally directed into the mouth of the Eustachian tube, as well as in certain pathological changes in the mucous membrane—for example, rhinitis sicca, more noticeable on the inferior turbinate body than elsewhere—that his principal interest lies.

Posterior rhinoscopy consists in the examination of the naso-pharynx by means of a mirror. The patient slightly throws back the head, the mouth is opened, and the tongue gently but firmly depressed by means of a tongue depressor, the most generally serviceable pattern being the old-fashioned one with a blade of large size, as it causes less irritation, and keeps down the entire tongue better than the smaller patterns. A small mirror—either one worked with a hinge, so that it can be elevated or depressed at pleasure (Michel's), or a small-sized laryngeal mirror, with the mirror bent at a right angle to the shaft—is passed gently backwards over the base of the tongue, care being taken not to touch the posterior pharyngeal wall, and it is possible to observe the reflection, part by part, of the whole of the naso-pharyngeal cavity. This procedure requires constant practice if valuable clinical data are to be obtained, and no opportunity should be neglected of acquiring and maintaining the necessary dexterity. It is necessary that a soft palate be relaxed in order that a good view of the parts above and behind may be obtained ; this relaxation is obtained by directing the patient to breathe through the nose without closing the mouth. Posterior rhinoscopy will be assisted by spraying the fauces in those patients with irritable throats with a small quantity of a 5 per cent. solution of cocaine ; and a relaxed and passive condition of the palate may be occasionally obtained by placing the palm of the hand over the patient's open mouth, and directing him to respire through the nose. Before the presence of abnormal conditions can be diagnosed. a knowledge of the normal anatomical appearance is necessary. The vault of the healthy pharynx is of a pale pink colour. and should extend considerably above the fornices of the choanæ. The orifices of the Eustachian tubes, with their projecting lips. should not extend sufficiently into the cavity to obstruct at all the view of the lower part of the choanæ. The posterior free edge of the septum formed by the vomer is straight and thin; and on each side. projecting into each choana from without inwards and downwards. are seen normally two pale pink unciform processes. the posterior extremities of the inferior and middle turbinate bodies. while in a relatively small proportion of cases may be observed in the upper part of the choanæ the free edges of the superior turbinate bodies. The more frequent abnormal conditions met with consist in

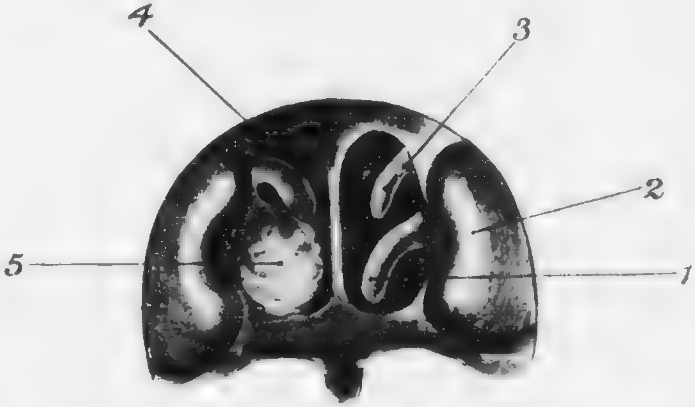


FIG. 20.—DIAGRAMMATIC SKETCH OF POSTERIOR NARES. RIGHT SIDE IN DIAGRAM IS NORMAL.

1, Inferior turbinate body, posterior extremity ; 2, pharyngeal extremity of the Eustachian tube ; 3, middle turbinate, posterior extremity ; 4, adenoid mass, showing how the fornix of the posterior nares is hidden when this growth is present ; 5, enlargement of the posterior extremity of the inferior turbinate body.

an undue development of lymphoid tissues about the roof of the naso-pharynx. This overgrowth is known as adenoid vegetation (Fig. 20. *4*) ; and in well-marked cases the roof of the chamber is lowered so much that the fornices and upper part of the nasal septum are invisible, and the roof, instead of appearing as a high vault, is convex and rugose, the whole of the space between the Eustachian tubes being occupied by the hypertrophic mass. In less severe examples it becomes most important to note whether the fossæ of Rosenmüller are free or occupied by lymphoid tissue, since in this site even a small amount of morbid growth will prevent free ingress of air into the Eustachian tube, by interfering with the movement of its free or posterior lip, and also by the extension of inflammatory catarrhal changes from the adenoid growth to the ostium.

There are numerous instrumental devices for holding the soft palate forwards in order to obtain a better view of the naso-pharynx in those patients who are unable to exercise sufficient self-control to keep the soft palate dependent and passive. By the aid of a little cocaine and the exercise of patience, however, the use of such instruments and methods, which are extremely unpleasant to the patient, are in most cases avoided, and they ought not to be resorted to unless it is otherwise impossible to obtain the necessary information ; nor should the practice of introducing the finger into the naso-pharynx to confirm the presence of adenoids be adopted as a routine measure. It is not usually necessary to do so even in quite young children, for the use of a post-nasal mirror is usually possible ; and the introduction of a finger into the naso-pharynx frightens and, if roughly performed, hurts the child, rendering subsequent treatment less easy on account of the terror and distrust of the little patient. The following facts will in the great majority of cases determine the presence of adenoid vegetations in the naso-pharynx without any such investigation : A subject of adenoid vegetations snores at night, and is a mouth-breather, with dry lips, usually has a high palate, and there will always be granules present in the oro-pharynx. These signs, combined with either the presence of or the history of discharge from the ear or deafness. or the existence of an alteration in the direction and integrity of the cone of light on the tympanic membrane. are sufficient indications of naso-pharyngeal obstruction of this kind. (For the facial appearances in these cases, see *ante*. p. 24.)

Another frequent and extremely important deviation from the normal is an enlargement of the posterior ends of the inferior turbinates (Fig. 20. *5*). which become round masses, filling up sometimes the lower part of the choanæ. and projecting backwards for a considerable extent into the naso-pharynx. The appearance of these swellings varies much both in colour and size. They may look like mulberries. dark in colour. with a nodular surface ; sometimes they are large masses, smooth and red ; at other times white and glistening, resembling a nasal polypus. Similar changes to the last are noticed, but less frequently, in connection with the middle turbinate. Other nasal conditions. such as the presence of polypi. adherent crusts. or an atrophied state of the mucous membrane. though frequently observed. have. with the exception of atrophy. little direct bearing on aural disease ; but they should always be noted. with the view of treatment upon general principles.

As part of this examination. the size of the faucial tonsils, and the colour of the mucous membrane of the posterior wall of the pharynx, are to be observed, enlargement of the faucial tonsils in children being rarely unaccompanied by enlargement of the post-nasal lymphoid tissue. It is rare that ablation of the faucial tonsils alone will be of any assistance in correcting the aural trouble. The pharyngeal wall should be inspected for the presence of the scattered and enlarged collections of lymphoid tissue surrounding the mucous glands of the part. manifested by small elevations. pale and glistening when there is no active catarrhal state present. but otherwise bright red. This condition is known as ' granular pharyngitis.' Inflammation of this kind and in this situation. whether acute or chronic. is pathognomonic of a post-nasal catarrh. the irritating mucus flowing over the pharynx causing the lymphoid tissue which surrounds the pharyngeal mucous glands to become swollen

CHAPTER III

SPECIAL SYMPTOMS AND THEIR IMPORT

Deafness.—The relative amount of deafness, from slight dulness of hearing to absolute deafness, requires careful consideration, with its onset, duration, and apparent causation.

Otalgia, or Pain in the Ear.—Pain is present in all acute inflammatory disorders, especially if tending towards or accompanied by suppuration, whether it be in the middle ear or external meatus. In acute eczema of the ear the pain is of a burning character, but not very acute. In furunculosis of the meatus it is severe, lancinating, stabbing, or throbbing in character, and usually prevents the sufferer from obtaining sleep for several nights. Pain is present in the most marked degree in acute inflammation of the middle ear. In infants it will be detected by the child crying whenever the ear is touched or washed, or by the frequent placing of the hand over the ear and rolling of the head about on the pillow. These signs may be accompanied, when the inflammation is secondary to a broncho-pneumonia, by retraction of the head. In adults, pain in acute otitis media suppurativa is often most excruciating, and, though worse, resembles in character a severe toothache. That which accompanies acute exacerbations of chronic suppuration in the middle ear is less severe and less localized. When due to the presence of a focus of suppuration in the temporal bone or to an abscess between the skull and the dura mater it may be very severe, as well as quite localized, is often more neuralgic in character, radiating over the side of the head and down the neck. Pain over the side of the head, and extending down the neck, with tenderness of the skull on percussion or pain in the occiput, should direct attention to the possibility of intracranial mischief. Pain is by no means an unusual symptom in chronic non-suppurative middle-ear disease. Here it is neither severe nor constant, and is more of an aching character. By far the most serious form of otalgia is one which occasionally accompanies middle or internal ear disease, and is of a neuralgic character, almost unbearable in its intensity. Referred pain in or about the ear from diseases in neighbouring regions is occasionally met with. Dental caries is a fruitful source of otalgia, more frequently when the disease is in the upper jaw. In all cases in which no other cause is found, the most minute attention should be directed to the teeth, for frequently the offending tooth is apparently quiescent, and may be satisfactorily stopped. Especially to be noted in this connection are malignant disease of the pharynx and larynx and upper part of the œsophagus, quinsy, and pain is said to be due occasionally to nasal obstruction. Pain or tenderness on palpation over the mastoid will always lead to a suspicion of inflammatory disease in the mastoid; and above and behind the ear, or severe frontal cephalalgia with discharge from the ear, to intracranial suppuration.

Ulceration of the pharyngeal extremity of the Eustachian tube may also give rise to ear pain.

Patients of middle age and upwards occasionally complain of severe pain in the ear, and when upon a careful examination nothing can be found in or around the ear arising from any of the aforementioned causes to account in any way for the pain, deafness being usually absent, the temporo-maxo-articulation should be carefully examined, as it may frequently be the seat of an arthritis, the close proximity of the joint to the ear leading the patient to refer the pain to that part.

Discharge. The character, consistency, quantity, and colour of the discharge should be carefully investigated. It may be offensive or odourless, purulent, watery, or sanious; if purulent, it may be thin or ropy. Discharge is present in the following diseases:

Eczema of the External Meatus.—The discharge is either watery or gummy in character. It is rarely purulent, and when so, occurs in cases of long duration, when it will have a faint offensive odour, due to the presence of decomposing epithelium.

Otomycosis as a cause of eczema is equally a cause of discharge, as is at times in cerumen.

Furunculosis of the Meatus.—Very severe pain always precedes the discharge in these cases. The latter is thick, scanty, and purulent, and can be detected coming from a solitary spot in the outer part of the meatal wall, and not through a perforation in the membrane or through a sinus in the deepest parts of the meatus.

Otitis Media Suppurativa Acuta.—The discharge is occasionally watery or sanious at the commencement, but gradually after a time becomes purulent, and may be ropy in consistency.

Otitis Media Suppurativa Chronica.—The discharge here may vary from an almost imperceptible moisture within the canal or a slight staining of the pillow-case at night to a profuse and continuous discharge. It may be most fœtid, or, on the contrary, odourless; usually purulent, but at times almost watery. It is occasionally tinged with blood from the presence of polypi or granulations, or at other times the presence of small flakes of carious bone will have been noticed by the patient, in which case it is sometimes said to have an odour peculiar to diseased bone; or will show small flakes of exfoliated epithelium of cholesteatomatous origin.

Otitis Media Hæmorrhagica.—This disease, which most frequently follows influenza, though not invariably, is characterized by the discharge of blood from the external meatus. This bleeding may be confined to a single discharge, or may be repeated.

Fracture of the Base of the Skull.—Should the fracture have passed through the temporal bone, blood will flow from the ear, and is sometimes followed by a more or less copious escape of watery discharge of low specific gravity—the cerebro-spinal fluid.

Malignant Disease of the Middle Ear or Meatus.—The discharge is scanty, often very offensive, and sanious.

Vertigo.—It is perhaps hardly necessary to remark that vertigo is by no means necessarily of aural origin, but that it may arise from numerous other morbid states of the system. Aural vertigo may be divided into two distinct classes—general vertigo and specific vertigo.

By a general vertigo is understood that variety in which there is no specific tendency for the patient to fall, nor for objects to revolve, in a particular direction. It is a symptom in chronic non-suppurative disease of the middle ear, especially in that of the sclerotic type. The attacks are sudden in origin and vary much in severity, from a transient giddiness to an almost complete loss of consciousness, causing the patient to fall to the ground. It is also present in all instances in which there is undue pressure within the labyrinth, such as occurs, for example, occasionally in gouty people and in the hæmorrhagic effusions of leucocythæmia. It may also be caused at times by syringing when the drum is intact, and a forcible jet of water is sent directly against the tympanic membrane. Especially when the membrane is perforated, the use of too cold or too hot lotions may cause vertigo. It is for this reason that a patient should always be seated while his ears are being syringed. With the exercise of every care, there are some individuals with sound ears who complain of giddiness whenever their ears are syringed.

Specific aural vertigo is due to irritation of one or other of the semicircular canals, in contradistinction to general vertigo, which is due to a general disturbance of the labyrinth, or to some force acting directly or indirectly on the fenestra ovalis. Specific vertigo has characteristics peculiar to the semicircular canal affected. If this is, as is most frequently the case, the external semicircular canal, objects have a tendency to rotate in a horizontal plane from the affected towards the sound side. If it is the superior canal, objects rotate in a vertical plane, and the patient tends to fall forwards; and with the posterior, backwards. Specific vertigo is occasionally noticed when syringing the ear in chronic suppurative disease or after the performance of the radical mastoid operation. In these cases it is due to erosion of the bony semicircular canal, while in inflammatory conditions of the temporal bone caused by the same disease, this vertigo may be spontaneous, and is due to osteitis of the surrounding bone. In both cases it will be accompanied by a lateral nystagmus.

Severe general vertigo is a frequent symptom in inflammatory disease of the labyrinth and abscess of the cerebellum. It may be caused in rare instances by a tumour pressing upon or involving the auditory nerve within the skull. Vertigo is also the chief symptom in Menière's disease and in effusion within the labyrinth (see p. 254 *et seq.*).

Tinnitus, or Noises in the Ear, may be divided into subjective, or noises referred to the head and noises referred to the ear, and objective sounds heard by others as well as by the patient.

Noises referred to the Head are either due to aural disease, or they may have a cerebral origin. In the former instance they have a hissing or singing character, are fairly constant and uniform in intensity, and often of long duration. When of cerebral origin, they occur as an early sign of mental derangement, and gradually take the character of voices ; and when tinnitus of aural origin commences to assume such a character, it is an indication for careful inquiry into the patient's mental condition.

Noises referred to the Ear.—These may be present in both suppurative and non-suppurative disease of the middle ear. They are more amenable to treatment than the foregoing, and are not infrequently considerably mitigated by intranasal treatment. There are two chief varieties of subjective sounds—a pulsatory one, synchronous with the heart's beat, and due to an abnormal transmission of the sounds of the heart ; and tinnitus proper, due to a distinct intralabyrinthine cause. These latter sounds are described by the patients as being of a hissing, whistling character, at times likened to the noise of a boiling kettle, whilst occasionally hissing or loud musical notes are complained of. The singing sounds are the most constant, though the louder noises are perhaps the more annoying. The pulsatory sound is, as has been said, due to some abnormal condition either of the cardio-vascular system or to some fault of bone-conduction, which causes the sound of the heart's beat, usually inaudible, to be heard by the patient. That this is frequently due to some trouble in the vascular system may be deduced from the fact that drugs, such as digitalis, which act directly on the heart and bloodvessels, are very useful in controlling the unpleasant symptom. The hissing or singing tinnitus is always more complained of at night or on rising in the morning—a fact which is partially due to the relative absence of extraneous sounds at these times, or it may be to the change of position. Rarely a clicking noise due to spasmodic contractions of the stapedius muscle is complained of.

Whilst tinnitus rarely prevents sleep, sufferers from this trouble frequently experience considerable difficulty in getting to sleep. In neurotic patients it may become so distressing and intolerable as to lead them to commit suicide. When tinnitus is complained of, and seems out of proportion to the aural disease, the blood-pressure should be taken and the urine should be examined for albumin —a clinical rule worthy of extension to all these cases.

Objective Tinnitus, or noises audible to others also, are either due to a more or less voluntary contraction of the tensors tympani or palati, or the heart-sounds may be heard by the auscultatory tube. The muscular contractions are often audible without the aid of the tube.

Symptoms caused by Drugs.—Certain drugs cause both deafness and tinnitus, particularly quinine, the salicylates, and antipyrin. The deafness caused by these drugs usually passes away more rapidly than does the tinnitus. Although the administration of these drugs in patients with normal ears will cause no permanent ill-effects, it is well, in patients suffering from chronic non-suppurative diseases of the ear, to exercise great care and circumspection in prescribing these remedies, as, according to Friedreich, there is a possibility of causing an effusion into the labyrinth, an accident which would intensify the aural trouble.

Facial Paralysis is often seen in cases of slight and transitory middle-ear inflammation, in acute suppuration, and in chronic suppuration.

Paralysis of the Sixth Nerve is seen as an occasional symptom in labyrinthine suppuration, in the mastoiditis of children, and in meningitis and cerebellar abscess.

Nausea and Vomiting.—These are symptoms which present themselves in increase of intralabyrinthine pressure, such as occurs in inflammation of the semicircular canal and in Menière's symptoms. They are also occasional accompaniments of the vertigo which may occur during the progress of non-suppurative disease of the middle ear. Vomiting may be present in all forms of aural suppurative disease in which septic absorption has occurred, and is a prominent symptom in intracranial complications. When the vomiting occurs with cerebral or cerebellar abscess its onset is sudden, and without connection with the ingestion of food.

Rigors.—Rigors, however slight, are of great importance, and are found in a great number of septic processes due to middle-ear suppuration. They are most severe, and accompanied by the highest temperatures in septic infection of the lateral sinus, and in such cases are usually repeated; they are present, though in a less marked degree, in septic meningitis and in acute cerebral infection.

Nystagmus.—Nystagmus is met with as a symptom in mastoid disease, in affections of the semicircular canals, and in cerebellar abscess or meningitis.

Paracusis Willisii.—By this term is understood that symptom of aural disease in which the patients hear better in a noise or when travelling in a noisy vehicle.

Autophonia is a term used to convey the information that the patient hears his own voice very loudly, while he is more or less deaf to extraneous sounds.

Delayed Hearing.—Delayed hearing results partly from a want of attention on the part of the patient whose sense of hearing is gradually becoming less and less acute, and partly on account of the trouble which is necessary in deaf people, or those slightly hard of hearing, of always being on the *qui vive* to avoid missing the introductory words of a sentence or remark. One sees this particularly in children who say "What ?" and if no reply is given often by their next remark prove that they really heard what was said. It is possible that part of this delayed hearing is a gradual loss of automatic action between the auditory and allied cerebral centres, that the delayed hearing is in reality sluggish perception and appreciation. This delay often is so marked as to be capable of being timed.

Hyperacusis, or painful hearing, is usually a symptom of central or neurasthenic origin.

Diplacusis is a condition in which the ears hear a given note at different pitches.

Diabetes and Glycosuria. When one realizes how frequently these conditions occur after middle age, it becomes obvious that these patients, owing to their lowered vitality, must be rather more prone to acute inflammations of all sorts than are the more healthy members of the human race. It therefore behoves us to consider the bearing of that wise general dictum --if possible, to avoid the knife in diabetic or glycosuric patients. Thus, our attempts at cure in the earlier stages of acute otitis media should be more vigorous and determined, if possible, than usual. But if operation has to be performed, it is equally important that the operation should be done without undue loss of time, so as to localize the disease and render the operation as simple as possible. But whatever we may do, an acute otitis media occurring in a diabetic or glycosuric subject is a cause for grave anxiety.

INDICATIONS FOR INTRANASAL TREATMENT

Some general principles must be laid down for the guidance of the practitioner in deciding whether or not special treatment should be directed to the nose and naso-pharynx in cases of deafness and aural disease generally. With regard to the presence of adenoid vegetations, their removal is practically invariably necessary for the cure of discharge from the middle ear in children, and should be promptly undertaken in every such case after the subsidence of all acute symptoms, both aural and nasal. The presence of adenoid vegetations cannot be looked upon as harmless when there is the slightest deafness detected, or when there is the least deviation from the normal in the curvature of the membrana tympani, as shown by the appearance and situation of the cone of light. Also, it [illegible] be allowed that the presence of these growths renders the occurrence of aural complications more likely in all cases of nasal catarrh; they are, further, a distinct complication in the exanthemata and in other febrile disorders. The question of the removal of adenoid vegetations in all cases where they are found is one on which there exists some diversity of opinion. Viewing the matter from the general point of view, as soon as their presence is noted to any material extent, their removal for aural prophylaxis alone appears undoubtedly to be indicated.

There exists, however, a certain number of cases in which removal of the adenoid vegetations in non-suppurative disease of the middle ear will be unattended by any good results on account of the advanced stage of the aural disease, as even in children cases of sclerotic middle-ear diseases occur. When a catarrhal deafness has ceased to be amenable to treatment, no benefit as far as the hearing is concerned will follow the clearing away of these growths.

For the undertaking of operative procedures for the removal of intranasal deformities or for the relief of deafness, the indications are easily and clearly defined. Speaking generally, unless it is possible to improve the hearing by means of an inflation by the Eustachian catheter or by politzerization, the removal of hypertrophies of the mucous membrane or deformities of the septum is not likely to afford any aural amelioration. Intranasal surgery may be undertaken with advantage if it is possible to render more lasting any benefit obtained from special attention to the ear. This may be said to be so in most cases, especially those of catarrhal deafness, where relief has followed inflation of the ears. Here the removal of the enlarged posterior ends of the inferior turbinates is of all operations the most effective, both in improving hearing and in the relief of tinnitus, especially when the patient complains of a dull sensation in the region of the mastoid process.

In aural therapy, the removal of spurs, the correction of deviation of the septum, and the reduction of enlarged inferior turbinates to their proper size, have for a further indication the necessity of a free and straight passage in the inferior meatus for the purpose of the introduction of the Eustachian catheter when even by modifications of the curve the surgeon is unable to pass it. The direct benefit to the ear in these cases is doubtful, and the operator should be very guarded and clear in his prognosis as to the curative effects of any measures directed towards correcting such pathological or abnormal conditions.

The use of nasal irrigations in all cases of atrophic or hypertrophic rhinitis, when combined with non-suppurating middle-ear disease, should be a routine direction. A judicious use of the galvano-cautery is often beneficial, inasmuch as, though its results are not permanent, the improvement in hearing obtained after its employment proves the possibility of operative measures of greater extent being useful in the same way.

CHAPTER IV

ESTIMATION OF THE ACUTENESS OF HEARING

THE most essential part of the aurist's art lies in the ability with which he is able to apply the necessary tests for ascertaining with the greatest accuracy the state of the hearing power of the individual, and the road to success lies in the thorough comprehension of the meaning to be derived from those tests ; therefore it is above all important that a thorough knowledge of the practical application of these tests be acquired by constant practice, so that experience may enable him to obtain the best results, and to classify scientifically his observations.

We have at our disposal many means, mechanical and otherwise, by which we estimate both the relative and actual state of the acuteness of hearing. The following are the media principally used : The human voice, tuning forks, the watch or acoumeter, Galton's whistle, Edelmann's pipes, König's rods, Stultz's monochord, and last, and of by no means the least value, Marage's syrens. Of all these methods of testing, the human voice is by far the most important, but, most unfortunately, it is at the same time the least satisfactory in its results, since by a careless use it may demonstrate improvement where none exists, or, on the other hand, no increase in the hearing power for the voice is noted when other tests show of its existence. This is largely, no doubt, on account of the want of methodical training on the part of the aurists. But it is also by no means entirely due to that cause, for voices vary in their clearness as much as, or more than, musical instruments. It is impossible to standardize voice tests, nor have we any formula which will reduce to a common level all tests made by the same voice in rooms of different sizes and of different acoustic properties.

All sounds possessing the same number of vibrations per second, though produced by various agencies, have different characteristics, by which they may be detected or separated from one another by the human ear or by mechanical means. It must follow from this that all these sound waves, though giving the same number of vibrations per second, must have waves giving a different curve. An assumption is justified that those sounds, having different curves, whose vibrations are the same in number per second, will each not only have, besides their different ways, a different penetrating power, in the same way that lights of different colour, but of the same intensity, have different powers of penetration. For this reason the sound produced by a tuning-fork, a whistle, an organ, or a string, will often give different results when a patient is tested with two or more of them. For the present, however, for practical work one relies upon those media for testing to which we have already alluded.

Testing with the Human Voice.—In testing with the human voice, the examiner stands on one side of the patient, whose other ear should be tightly closed by the insertion of the finger, and care must be taken that the patient is unable to observe the mouth of the examiner. It is also well to keep the patient standing at least 2 or 3 feet from a hard wall; but if the patient is standing against a curtain there is no necessity for him to be removed any distance from it, as in the former case sound may be deflected from the wall, whereas the curtain would break up the sound waves and prevent any reflection of them. Simple words make the best test, and those should be spoken in such a way that the various sounds are equally employed, and that the words are more or less known to the patient. It may here be remarked that when dealing with patients from other parts of the Empire, where the pronunciation varies very markedly from his own, the examiner is very apt to be deceived on account of the patient not recognizing the word which is being spoken. In this first test the patient is made to repeat out-loud the single words which have been spoken by the examiner, in a clear, even tone—that of ordinary conversation. The examiner then increases or diminishes the distance between himself and the patient, until he has arrived at the limit of hearing for that patient.

Besides the means that we have already mentioned, of cutting off the sound ear or the one which is not being tested, one has now a small instrument which is applied into the sound ear while the other is tested. This is the noise-producer of Báràny. There is a small knob which is kept pressed, which allows a hammer driven by clockwork to keep up a continuous series of sharp strokes on a small tense membranous disc.

When the patient is unable to hear ordinary voice, it may be necessary, as in cases of severe deafness, to increase the volume of sound by speaking in a louder voice. On the other hand one has to employ a lower voice than that of conversation—that is, the whisper—in order to detect the slighter grades of loss of hearing, and in more advanced cases to be able to estimate the ratio of hearing between the conversational voice and the whisper. The whisper must be of very great uniformity, and the proper method to adopt is obtained by emptying the lungs of as much air as possible, and then whispering single words, using the residual air for the purpose. One records one's observations under the titles of 'loud' or 'ordinary' voice, and the whisper as perceived at the respective distances noted after them, and by repeating this test at intervals the examiner is able to obtain an approximate appreciation of the progress of any case.

In making these tests, it is necessary to remember that certain vocal sounds travel better than others. The following is the order, taking the best travelling sounds first: Hissing sibilants and soft G's highly pitched; F sounds and explosive of medium pitch; deep tones. According to O. Wolf, letters when used singly should be taken in the following order: R (lingual), B, K, T, F, S, Sch, G (soft), U, D. In certain diseases some letters are heard worse than others. Thus, S and Sch are heard badly in diseases of the conducting apparatus, while F is so in labyrinthine disease, and R in defects of the membrane. The whisper is more rapidly lost in middle-ear disease and otosclerosis than in progressive nerve lesions.

Continuous-Tone Series.—By a continuous-tone series is implied the use of all the notes, inclusive of semitones, in the whole scale, from sixteen double vibrations upwards; but there are very few people who employ more than one tuning-fork in each octave, but Edelmann's pipes and Galton's whistle afford a continuous-tone series over many octaves, commencing at C, 256 double vibrations. These pipes, which are on the basis of a closed organ-pipe, are capable of being elongated, and the mouth of the pipe can be altered in size. By means of three pipes a continuous series of tones may be obtained, commencing at C^2 in the lowest, and ending at A^1 in the second. The highest of these pipes commences at or about A^4, and terminates at the highest audible note capable of being heard by the human ear, of 50,000 vibrations per second. The lower-tone pipes are employed in proving the existence of nerve lesions, for it will frequently be found that one or more notes will not be heard. The highest one, or Galton-Edelmann whistle, is employed to detect the upper-tone limit, and in cases of nerve lesions this will be considerably lowered, though a low upper-tone limit must not in itself be considered as a sign of disease, for in the human being individuals whose hearing is in every way good will be found with a low-tone limit, and if this tone limit is sufficiently low, appreciation of musical-stringed instruments, which call into existence very high harmonics, as an integral factor in the production of that auditory sensation from which pleasure is derived, will be impossible.

Marage's instrument consists of a series of syrens worked by an electro-motor, which, together with artificial naso-pharyngeal cavities, are capable of producing the principal vowel sounds, or something resembling them so nearly, as to be practically as good as the human voice. He has also dials which give the amount of force or intensity requisite to produce the note emitted by the syren in use, and by this means one is able to record in a graphic manner the various sounds and how they are heard.

The Watch, or Acoumeter.—The acoumeter is a small instrument invented by Politzer, in which a short metal bar (Fig. 21, C) is struck by a small hammer (Fig. 21, A), and, as all acoumeters are made exactly to the same pattern, a uniform sound is arrived at, thus enabling observers in all parts of the world to express their results by one standard. This instrument should consequently be used whenever possible in preference to a watch. If, however, a watch is adopted, the observer should carefully test the limit of distance at which the tick of the watch is perceived by a person with normal hearing, and any results he records should be in the form of a fraction, with the limit of distance in inches as the denominator. As the watch gives a more musical sound than the acoumeter, the results obtained in any case, if both are employed, may not correspond.

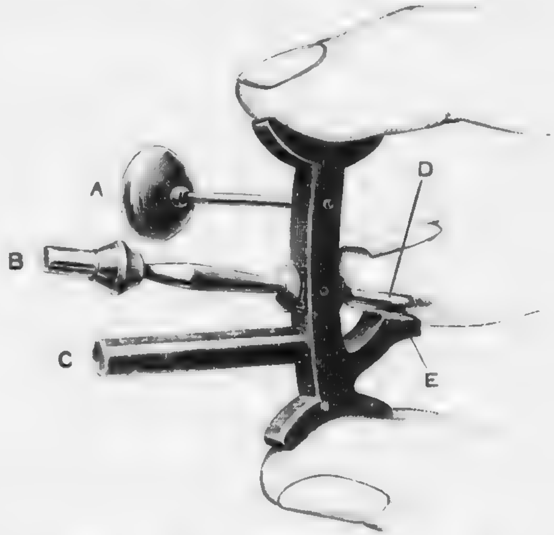


FIG. 21.—POLITZER'S ACOUMETER.

A, Disc for applying to mastoid; B, hammer; C, metal bar; D, lever; E, stop to insure constant strength of stroke.

In examining with either watch or acoumeter, the ear not being investigated must be closed. The instrument is then placed close to the ear, and moved steadily away until the sound is no longer perceived. Undoubtedly by this means the patient is, as it were, able to follow the sound further than if the instrument is gradually approached to the ear; but whether the watch be removed from or approached to the ear, *that method must be rigidly adhered to.* In this test a silent room is more important than when using the voice test.

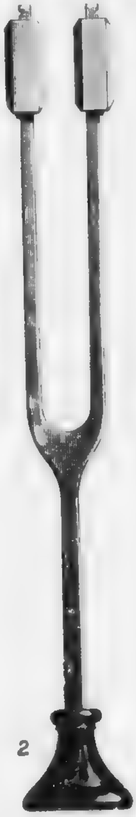


FIG. 22.—LUCAE'S TUNING-FORK (C).

2. Vulcanite foot-piece.

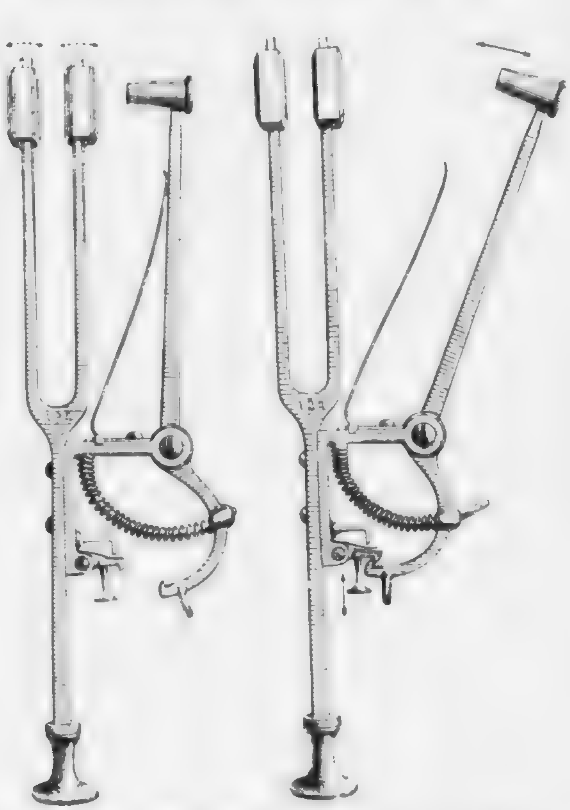


FIG. 23.—PROFESSOR LUCAE'S LATEST FORK.

The left-hand figure shows the hammer at rest, the right one ready for use. The fork is tuned to vibrate exactly the minute, and thus eliminates the personal factor.

A source of fallacy in this test lies in the fact that if the watch or acoumeter be approached to within 3 feet of a wall, the sound is intensified to the listener, and the hearing distance thus made quite fictitious and misleading.

Both the human voice test, and that of the acoumeter should be repeated after inflation of the middle ear, and any difference in the results noted, as having an important bearing upon the diagnosis and prognosis.

Tuning-Forks.—The examination of the patient's acuteness of hearing, or the estimation of his relative deafness, depends in a very large measure on the skill and knowledge which we bring to bear in the employment of tuning-forks, and the comprehension of the results so obtained, and, above all, upon a clear understanding of the bearing of these results upon those derived from other varieties of testing.

The note or pitch of the tuning-fork most usually employed is either C or A. The C tuning-fork has, perhaps, the advantage of being the one more commonly employed, owing to which a comparison of the results obtained by different observers is the more easy. The pitch of A, however, has the merit of not being in harmony with the more common sounds of traffic and such-like, and so is more easily distinguished by the patient. But it is advisable not to employ tuning-forks of different notes unless they are employed in all the octaves.

If it is proposed to employ only two forks—the minimum, that is to say, with which any intelligent work can be done—the fork of C of 128 and of C^2 of 512 vibrations should be used, or the A forks in the corresponding octaves. It is well to remark here that when one speaks of the vibrations of tuning-forks double vibrations are understood; whereas in all other instruments single vibrations are alluded to—an unnecessary complication, but customary.

In order to obtain the most regular and definite results from tuning-fork tests, it is requisite that a fork, not only of absolute accuracy with regard to pitch, but of a regulation form, size, and weight, be used for the chief or fundamental tests. The tuning-forks which best comply with these conditions, and which fulfil our requirements, are those of Lucae. Of these, the one depicted in Fig. 22 is inexpensive, and will answer all purposes, but is seen in Fig. 23 in its latest and most reliable form. The particular advantage which this latter fork possesses when compared with others is that the spring which is used to propel the hammer which strikes the tuning-fork and sets it in vibration is of the same strength in all cases, and thus the tuning-fork can be accurately timed to vibrate always through the same period of time. By this means is eliminated to a great extent the personal factor, and it is rendered difficult for errors to creep in when this fork is used, although we have probably not yet arrived at obtaining an inexpensive and thoroughly reliable standardized fork which will invariably give exactly the same results as any of its fellows.

The other forks which are employed commence at the lowest C of 16 double vibrations per second, and ascend as high as C^6 of 8,192 double vibrations per second. In employing the ordinary tuning-forks—that is to say, other than the fork depicted in Fig. 23—the following direction should be carefully observed and invariably followed:

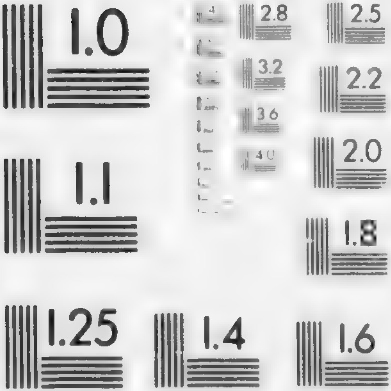
The fork is to be struck with or upon a hard substance protected by a soft covering, and the point of impact should be nearer the shaft than the tip of the prong. Before placing it on the patient's head, it should be listened to by the observer, in order to be sure of the absence of overtones. The practical importance of this caution lies in the fact that, if the test is made with a tuning-fork emitting overtones at one time and without doing so at another time, the patient is for all practical purposes being examined with tuning-forks of different pitches. In testing with a high-pitched tuning-fork, the observer must not strike the fork too hard, for if the note is above a certain intensity, it will be perceived by the sound ear, even if it be occluded as much as possible by the finger, well moistened, and inserted into the meatus. Thus, in the case of C^3 of 1,024 double vibrations, the tuning-fork must not be struck in such a manner that it vibrates for over thirty seconds and in the case of C^4 for over forty-five seconds. This the writer was able to prove in a case in which the whole membranous cochlea, together with its bony covering, had been removed in a case of necrosis of the labyrinth. In estimating, however, the bone conduction, it may be necessary to strike the fork extremely hard in order to be able to stimulate an auditory nerve whose powers of conduction are almost destroyed.

Air Conduction.—When the observer is estimating the air conduction of the patient, the tuning-fork must always be held to the ear in the same way, with the tip of one of the prongs close to the patient's external auditory meatus. If the observer is not using one of the tuning-forks of Lucae, which is caused to vibrate by the spring hammer, and is obliged to use his own powers of perception, it is well that he should, if possible, be tested himself, in order to ascertain whether his powers of perception by air conduction are normal. Otherwise he will necessarily obtain faulty results. In noting the time duration of air conduction, it should be stated in seconds and not given as 'normal.' Occasionally it will be found that the perception of the air conduction of a tuning-fork will be longer than is usual.

Bone Conduction.—The base of a vibrating tuning-fork is applied to the patient's mastoid, and as far as possible is always applied with the same amount of firmness and in the same position over the mastoid antrum—that is to say, close behind the auricle, and on a level with the top of the external meatus. The reason for selecting this particular spot is that the structure of the mastoid itself varies considerably, either from it being so hollow as to consist only of a few large cells, or being of uniform density, and formed of almost compact bone; but if the base of the vibrating fork be placed over the mastoid antrum, one obtains the most equable conditions possible under the circumstances. Having so placed the fork, the patient should be directed to raise the hand or finger the moment he ceases to hear the sound. But he should also be cautioned not to confuse a feeling of vibration with one of the hearing of sound. With the latest pattern of tuning-fork the duration of bone conduction is simply checked by a stop-watch, and the results recorded according to the normal duration for that particular fork. But if the non-mechanical form of fork is employed, as soon as the patient's hand is held up, the fork is rapidly transferred to the observer's mastoid, and *vice versa*; and according as the observer hears

MICROCOPY RESOLUTION TEST CHART

ANSI and ISO TEST CHART No 2


1.0
2.8
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APPLIED IMAGE Inc

it a longer or a shorter time than the patient, so the record is made on the testing chart as minus or plus the number of seconds which represents the difference. If the patient's hearing and the observer's hearing by bone conduction are represented by the same duration of time, it is better that this be expressed by ±0.

The duration of sound by bone conduction is influenced by the relative strength of vibrations which are able to exert their influence through the perilymph on to the organ of Corti. Under certain conditions, if the pressure on the stapes is increased and consequently the pressure on the peri- and endo-lymph is subject also to an increased pressure, bone conduction will be diminished, and this result will be increased if there is any interference with the free passage of air through the Eustachian tubes. This is shown clinically by testing persons before and during their stay in a compressed-air chamber. And from this, as we shall see when talking of Gellé's test, that fixation of the stapes may be assumed under certain conditions, and consequently the loss of its safety-valve-like action, which probably has the effect of diminishing the hearing power, especially should the peri- and endo-lymph be at all excessive in quantity. But whether the converse holds good, and the diminution of intra-labyrinthine tension may occasionally account for increased bone conduction, is not known, but it is extremely probable, in view of the effect of the loss of fluid in certain long-standing cases.

When employing the tuning-fork whether in air conduction or bone conduction, it is well to remove the fork from the ear from time to time, in order to rest the auditory nerve, for frequently in cases where the affection is largely of the auditory nerve, the nerve, as we shall see, becomes easily strained, and for this reason it is well to make observations, both with interrupted and with continuous tests.

This question of increased bone conduction presents extremely interesting problems, and it is to be noticed that both in inflammatory and in subinflammatory conditions of the middle ear this increased bone conduction is present. It is also present with the increased density and thickness of the bone and middle-ear structures present in otosclerosis and sclerotic changes in middle-ear disease; and, again it is present in acute and most cases of chronic obstruction of the Eustachian tube, as well as in certain hyperæsthetic states of the cochlea. If a Eustachian bougie is introduced into the Eustachian tube, bone conduction is prolonged in most cases. In the same way, if the external auditory meatus is obstructed with the finger, or any similar method, bone conduction is again increased. From like causes fixation of the stapes, in the oval window, whether that fixation be bony or fibrous, and also when the secondary membrane in the round window becomes thickened, bone conduction is increased, provided there be no destruction involving the auditory nerve, or cochlea.

Special Tests.

From time to time aurists of various nations have evolved certain combinations of air and bone conduction to form certain specific formulæ, from which their experience led them to make certain deductions. It is not proposed, however, to consider more of them than seems to be necessary.

When the term ' normal ' is applied to the appreciation of sound, the idea that one intends to convey is that the sound perception in the instance under consideration lies within certain limits known to exist in people whose aural apparatus is apparently sound, but which need not be any exact number of seconds for any specific tuning-fork, but that a little latitude must be allowed.

Weber's Test.—In Weber's test, the end of the shaft of a vibrating tuning-fork is placed on the vertex in the middle line of the skull in front of the ears, and is moved forward until heard by the patient. It may be necessary in this manner to traverse with the fork the forehead, bridge of the nose, upper lip, to the centre of the lower jaw. The patient is asked to determine on which side he hears the note the better.

This test, which is only of real service in one-sided deafness, is based on the following experiment :

If in a person of normal hearing, one ear is closed and the tuning-fork used as described above, the sound will be more distinctly heard in the obstructed ear; this fact is in all probability due to the reverberation of sound in the blocked passage. From this test in unilateral deafness we are able to make the following deductions: If the patient hears the sound better in the diseased ear, the trouble lies in the middle ear, or proceeds from obstructions in the meatus; the conducting medium is faulty. If, however, he hears the sound better on the healthy side, the disease is most probably in the internal ear, or auditory nerve; the perceptive media are diseased.

When there is nerve deafness forks of different pitch may give different results in this test, as islands in the diseased organ of Corti may retain their function.

Rinne's Test consists in estimating the length of time the patient hears the sound of the tuning-fork by bone and air conduction on either side as compared with the ratio of normal appreciation—viz., with C tuning-fork (Fig. 22) the air conduction is longer by thirty-five seconds than the bone, and with C^2 tuning-fork the air conduction is longer by fifteen seconds than the bone. The following is the method of interpreting the results: The test is 'positive' *when in a case of deafness* the fork is heard longer when held before the ear than when applied to the mastoid, and 'negative' when the sound is heard longer through the cranial bones. The positive thus indicates disease of the sound-perceiving, and the negative that of the sound-conducting, apparatus. This test is of the least value when the whispered voice is not heard 3 feet or upwards from the patient.

Gellé's Test. Bone conduction is diminished in the normal ear when the atmospheric pressure is raised in the external meatus by means of a Politzer bag, or some such instrument. The value of the test lies in the fact that if the footplate of the stapes is fixed no such diminution of bone conduction takes place.

The Proportional Test. The postulate of Rinne has been in existence for fifty-five years, and during that period has been largely recognized until quite recently as a correct and reliable law. It is, however, capable of being used as the basis from which the above-named test is evolved, and I have elaborated a series of subdivisions of Rinne's test, which I have named the proportional test. Each subdivision has its group symbol, under which title one is able to classify most pathological conditions affecting the hearing, and to make the groups to a large extent pathognomonic of specific conditions. The series is obtained by considering the differences in the relative ratios or proportions in which the air conductions and the bone conductions stand to one another.

The following six groups will cover practically every abnormal condition as illustrated by tuning-fork tests, but it must be clearly understood that by this test alone only a fair estimation can be obtained of the disease from which the patient is suffering, and that in order to verify a diagnosis all the other tests which one is in the habit of using are often required before one is able to assert with any confidence the exact condition of the patient's auditory apparatus. A C tuning-fork of 128 D.V. is used.

Group Symbol.	*Bone Conduction.*	*Air Conduction.*	*Rinne Positive or Negative.*
α	Normal	Diminished	Positive
β	Normal	Absent, or much reduced	Negative
γ	Increased	Normal	Positive
δ	Increased	Reduced	Positive Negative
ε	Diminished	Normal	Positive
ζ	Diminished	Diminished	Negative

α. In this group will be found cases falling under two categories, in the first of which are included those of slight and early nerve disease, in which the loss of air conduction is very slight in degree; in the second group we find acute or recent cases of otitis media, which may either be due to serous effusion into the middle ear, generally slight in amount, and chronic cases, or cases of long-standing disease, due to an obstruction of the Eustachian tube, with slight involvement usually of the middle ear.

β. Under this group, in which perhaps the largest number of cases is to be found, we find many which originated in some suppurative process, whether this be past or still present, but only when there is no serious involvement or destruction of ossicles or other parts of the middle ear. We have, besides, under this group symbol, a small number of cases which are due to severe lesions of the nervous apparatus of the ear—that is to say, lesions either traumatic or pathological, in which the central part of the cochlea alone remains undestroyed—that is, that part of the cochlea by which the sound perception of notes between C of 128 and C^3 of 1.024 double vibrations is perceived.

γ. In this group increased bone conduction is associated with an almost normal air conduction. This group is common in all classes of middle-ear disease and otosclerosis in their earliest stages, and in which the tendency of stapedial fixation is delayed; but this is somewhat uncertain. It is also applicable to cases of subacute inflammation of the middle ear. There is another variety of cases under this group symbol in which one finds a form of nerve disturbance, of osseous instead of aerial hypersensitiveness of the organ of Corti.

δ. As soon as increased bone conduction has become about ten seconds or more above normal, one ceases to consider the case as entirely due to middle-ear disease, and therefore this group includes especially the chief number of cases of otosclerosis of any intensity or duration although one is not even in this case able entirely to eliminate the influence of a nervous hyperacousis. One deals under this heading with cases both positive and negative. The positive cases are those in which the nerve element is alone present.

ε. Under this heading are included early middle-ear affections, nerve lesions secondary often to middle-ear disease, and many cases of neurasthenia, so that before one makes any attempt at formulating a diagnosis one should have first inflated the middle ear in order to be able to contrast the results before and after inflation. For by this means the proportional test when aided by other tests will enable an accurate diagnosis to be made.

ζ. The great majority of cases under this group heading are those of chronic Eustachian obstruction, combined with middle-ear disease, and also cases in which the obstruction has existed previously, though it is no longer present. And in this connection it may be well to assume that a loss of more than twelve seconds of bone conduction without evidences of neurasthenia means a corresponding loss in the conducting power of the auditory nerve, or of perception in the cochlea. And in many cases this loss of bone conduction is capable of considerable improvement, which proves that the affection of the nerve need not always be of a permanent character. And, lastly, under this group heading one finds numerous cases of otosclerosis or severe middle-ear disease, in which a degeneration of the auditory nerve or of its end organ is also present.

Fatigue Period.

If a vibrating Lucae's tuning-fork is placed on a patient's mastoid, and the period during which it is heard carefully noted, and if then the tuning-fork is struck and allowed to vibrate for about two-thirds of the already ascertained bone conduction, and then applied to the mastoid as before, the period of bone conduction will be found to be increased. The increase in bone conduction is due to fatigue of the auditory nerve, and is the fatigue period. It probably scarcely exists in the healthy individual with sound hearing. But in cases of disease it will be found to vary considerably, and to be greatest in all cases where the patient's general health is below the average, and where the eighth nerve is involved.

It is impossible at present to lay down rigidly any definite rule, but, generally speaking, one may say the greater the fatigue period the more definite the involvement of the nerve, although this may be, and frequently is, merely due to a neurasthenic condition.

This fatigue period, it will be found, is capable of seriously complicating Rinne's test, and it will be better, where one has reason to suspect the presence of this condition of the easily fatigued auditory nerve (when one is investigating Rinne's test), either invariably first to estimate the air conduction, and then place the tuning-fork on the mastoid and see if it is again perceived, or to do it both ways, first bone, and see if it is perceived through the air, and then air, and see if it is perceived by bone.

Anomalous Results in Tuning-Fork Investigations.

Occasionally one finds that a patient will inform one that the tuning-fork is heard in only one ear, even when it is placed on the opposite mastoid. This is no doubt due to one of the causes which have been described as causing prolonged bone conduction, which is present in a relatively high degree in that ear.

Another anomaly is when certain vibrating tuning-forks are heard only in one ear and other octaves in the other ear, when the forks are placed on the vertex. This appears to be caused by irregular areas of disease in the cochlea and on one side, and is a condition found exclusively in diseases of the cochlea.

Patients, again, will occasionally say that they cease to hear the tuning-fork, but still feel it. In these cases the patient must be instructed to take no notice of the sensation, but only to report what they hear.

Under certain middle-ear conditions, with involvement of the cochlea as well, one not infrequently finds that the ear will hear a fork sharp; this is merely an indication of perverted hearing on the part of that nerve, and may be due to temporary or permanent nerve disease.

Frequently in diseases of the cochlea it will be found that the upper-tone limit, as shown by Galton's whistle, is higher than that shown by the tuning-forks. The reason for this divergence is accounted for by the different penetrating value of the relative sound-waves, the sound-wave caused by Galton's whistle containing many overtones in its composition.

It will frequently be found in testing patients that the tuning-fork is not heard equally well by air when it is held at different angles with regard to the patient's head. When this has been noted, it should be registered, so that the tuning-fork is always employed at the same angle from the patient's head. This applies equally, or perhaps more, to a watch or acoumeter, when it is used.

Unilateral deafness of long standing often produces a remarkable development of increased range of auditory perception on the sound side. So considerable, indeed, is this increased audition, that pressing the finger into the sound ear is not sufficient to interfere with its clear perception of sound. It is consequently necessary at times to employ a small instrument called Báràny's noise-producer, by means of which the sound ear may be cut off entirely. No estimate of the hearing power of a severe unilateral character can be considered complete and unassailable unless this instrument has been employed to verify the voice tests and the air-conduction tests.

Education and Re-education.

Education of the deaf can only be considered in deaf-mutes, whereas re-education is considered for those who have become deaf after infancy, when they have once developed their faculty of hearing. Both education and re-education are, of course, absolutely the same in every particular, and there are numerous means by which this form of treatment can be carried out. It is essential that some form of continuous-tone series should be employed. There is the series of syrens by Marage, the electric-sound apparatus of Bourget, the harmonium of Urbanschitsch, and several others. There is also a very useful form of instrument made by the Æolian organ-builders. Whatever methods are employed, one should always remember that it is absolutely essential that a careful chart of the sound perception should be made before the treatment commences, and that an observation should be carefully made with great regularity. It is better that, when these patients commence their treatment, at the beginning the time occupied should be very slight—not more than one to three minutes—and it even seems better that the séances should be only once daily, although, if time presses, there is no reason against the patient gradually having as much as three to five minutes twice a day. It is no doubt better not to work principally on those notes which the patient is unable to hear by air conduction—that is to say, speaking of the partially deaf. And it is also better when one is able, not simply to run up and down the scale—*i.e.*, to take notes in their ordinary sequence—but that the intervals should be employed, such as the fourths.

With regard to indications and contra-indications of this educational method of treatment, one may say that all cases of nerve deafness should be considered as unsuitable, whereas all cases of middle-ear trouble are fit and proper ones. For all that, when deafness is complete, from nerve or any other lesion, such as occurs in deaf-mutes, of course the treatment is quite justifiable. As an easy method of education one may adopt the practice of letting the patient have someone to stand a little behind him, or to one side. The attendant then says as clearly as possible certain words, just sufficiently loud for the patient to be able to hear them, the patient repeating the words. One can frequently gradually lower the tone of voice as the patient gets more and more accustomed to picking up the sounds through bone conduction.

CHAPTER V

GENERAL THERAPEUTICS—THE USE OF INSTRUMENTS

Politzerization.—This is a term now used to designate all forms of inflation of the middle ear by means of the contraction of an indiarubber bag, forcing a blast of air up the nose and into the ear through the Eustachian tube. This method was invented by Professor Politzer, and has the advantage of being easily performed by the patient himself or by the medical practitioner unskilled in the use of the catheter. This method finds its chief indication in the treatment of deafness in children and old people. It is, however, not so delicate a means of inflating the ear as by the bag and catheter. It is more difficult to regulate the force of the air current, and it is impossible to confine the inflation to one ear, so that the sound ear may be inflated while the diseased one escapes. Again, those who are constantly in the habit of passing Eustachian catheters can do so with almost no discomfort to the patient, and those who have not acquired the art of catheterization should lose no opportunity of improving their manipulation ; their success in the treatment of aural diseases will be materially increased thereby.

To perform the act of politzerization an indiarubber bag of about 6 ounces capacity is the chief requisite. The ears of the patient and of the observer are connected by the auscultatory tube (see p. 69). The patient is then directed to take into his mouth a small quantity of water—about a dessertspoonful—and instructed to swallow it at a given signal. The operator next inserts the nozzle of the bag into one nostril, choosing the more patent side. With the finger and thumb of the left hand he now closes entirely the free nostril and any part of the other not occluded by the nozzle of the bag. He then gives the signal for the patient to swallow, sharply compressing the bag when the pomum Adami ascends, and observing, by means of the auscultatory tube, whether air has found its way into the tympanum or not. The patient's sensations are not entirely to be relied upon.

A modification of this method, introduced by Grüber, is the pronunciation of the word 'hic' instead of swallowing the water, the bag being compressed at the moment the patient phonates. In children it is sufficient to cause them to keep the mouth open, and in adults merely blowing out the cheeks with the mouth closed is often as efficacious as the other methods, and less troublesome.

The Eustachian Catheter. — One of the most important methods of diagnosis and of treatment is the proper use of the Eustachian catheter. The catheter may be either of metal or vulcanite, long or short, ball-pointed or plain. It is now customary to advise the use of a short catheter of from 4½ to 5 inches in length. To inflate the ear by its help an air-bag is required, with a nozzle fitting well and easily into the end of the catheter, and in addition an auscultatory tube; it is better to be provided with a fine spray apparatus filled with a 5 per cent. solution of cocaine. The lower meatus is first anæsthetized with a very small amount of cocaine, 3 minims or 5 minims being sufficient for either side. One end of the auscultatory tube is now placed in the patient's ear and the other in the ear of the observer; it should be so made as to retain itself in position, and should neither be held in the observer's hand nor touch the patient's or surgeon's clothes. The tip of the patient's nose is now slightly elevated with the thumb of the observer's left hand, the fingers resting on the forehead. The catheter is held in the right hand with the beak pointing towards the patient, and introduced into the nose with the shaft almost vertical. The outer end is then elevated so that the shaft lies horizontally, and passed gently but firmly back, the point resting on the floor of the nose; at the moment the tip of the catheter leaves the firm upper surface of the hard palate the catheter is rotated so that the little ring close to its mouth points more or less to the orifice of the external meatus on the same side. The catheter will now be engaged in the pharyngeal end of the Eustachian tube, and is maintained in its place by the finger and thumb of the left hand. The observer now notes carefully that the auscultatory tube is quite free, for if it touches any portion of the clothing adventitious sounds are created, and erroneous information derived from the sounds heard. The nozzle of the indiarubber bag is then inserted into the end of the catheter, and air forced up by sharply compressing the bag. In the event of the catheter failing to engage the end of the Eustachian tube, the point may be rotated towards the opposite ear, and the catheter gently drawn forwards until it strikes against the posterior edge of the septum nasi, when a half-turn will immediately cause it to engage in the tube. This method should not be employed unless the surgeon fails, after several attempts, to find the tube by the previous method. The other methods of passing the catheter are really inferior to the one just described, though they are, perhaps, in more general use.

Other Methods of Passing the Eustachian Catheter.—In all of these the catheter is passed directly backwards until it touches the posterior wall of the pharynx. In the first, when this has been done, its beak is then turned outwards so that it enters the fossa of Rosenmüller, a depression just behind the posterior lip of the pharyngeal orifice of the Eustachian tube. It is then drawn forwards with its beak pressed outwards, when it will be felt to pass over this posterior lip, after which the catheter is immediately turned slightly upwards, and it should then have engaged itself in the orifice of the tube. This method is recommended by Politzer as being most satisfactory.

Another plan is: After having touched the posterior wall of the pharynx, the catheter is drawn forwards for ¾ inch, and then rotated outwards, when the beak should enter the orifice of the Eustachian tube. This can scarcely be a satisfactory method, as it presupposes the naso-pharynx to be of uniform depth in all people.

A very safe method consists in drawing the catheter forwards, after having touched the posterior wall, with its beak turned towards the opposite ear, until the forward movement of the catheter is checked by the posterior edge of the vomer. The catheter is then rotated outwards through half a circle with the point downwards. The catheter will then invariably be found, if properly turned, to have engaged itself in the orifice of the Eustachian tube. This procedure has one great disadvantage, in that it is extremely disagreeable, and often painful.

When it is impossible to pass the Eustachian catheter down one nostril, catheterization may be done from the opposite nostril by passing the catheter and rotating it towards the Eustachian tube. The instrument must be rotated at the moment it passes over the edge of the hard palate, but it may be, and often is, necessary to make the curve of the catheter at its beak almost that of a right angle with the shaft.

The difficulties which are met with in passing the Eustachian catheter are due either to irregularities in the nasal passage or to irritability of the palate. To the experienced hand a nose so narrow and irregular, that the catheter cannot be passed with the aid of cocaine and delicate manipulation, is very rare. If obstructions are met with in passing the catheter in the manner described, with the beak on the floor, it must be rotated either outwards or inwards, or even passed with the point upwards, the catheter being held upwards instead of downwards at first, and pressed gently but firmly backward, regaining, if possible, the correct position after clearing the obstruction. It is sometimes necessary to make a bend in the shaft of the catheter, with the convexity on the same side as the loop; it occasionally helps considerably to straighten out partially the curve at the tip. Difficulty experienced in rotating the catheter is either due to the curve being too long or to the patient making tense the soft palate. If the curve is too great, the catheter must be withdrawn and the curve modified. Should, however, difficulty arise from irritability of the palate, it may be overcome by the help of cocaine, or by the exercise of self-control on the part of the patient.

Sometimes the catheter does not pass easily into the mouth of the Eustachian tube. The act of swallowing on the part of the patient will usually overcome this difficulty. The only danger in passing the catheter arises from the employment of unnecessary roughness, and the risk consists in forcing the tip of the catheter through the mucous membrane. Should this happen and inflation be proceeded with, emphysema of the palate may be set up, and it was due to such an accident many years ago that catheterism fell into disrepute. Without undue force or carelessness injury of this kind can only happen during a softened condition of the mucous membrane consequent upon an acute catarrh of the naso-pharynx.

Too much care in sterilizing catheters cannot be observed, although, so far as the writer is aware, only one case has ever been reported, and that long ago in another country, in which a serious disease was communicated by a dirty instrument.

The Auscultatory Tube.—This is a metal or rubber tube fitted with an ear-piece at either end. These ear-pieces are usually of different colours, in order that the examiner may be able to keep one for his own use. Separate ear-pieces for the patient of metal or glass are now obtainable. The tube is used primarily to detect the entrance of air into the patient's ear during inflation, and secondarily to form an opinion as to the state of the ear and of the patency of the Eustachian tube.

It is of great importance to remember that the use of this tube is absolutely necessary in those cases of disease of the middle ear where inflation by the catheter or Politzer's bag is used for diagnosis or treatment ; for, if the statements of the patient alone as to whether or not air enters the tympanum are relied upon, error is very likely to occur. The first cause of this error is that the patient suffering from advanced non-suppurative otitis media has usually lost, at any rate to a large extent, tactile sensibility in the mucous membrane of the middle ear. The second is that some patients will state that air has entered the ear on account of the unpleasantness of the process of inflation when it has not really done so. And, lastly, especially in hospital practice, the patient does not always understand thoroughly what to expect.

Information gained by the Auscultatory Tube in Inflation of the Middle Ear.—The sounds heard by means of this tube are of great use in diagnosis, but the finer appreciation of them is only obtained by practice and experience. The sound heard in any ear on inflation varies with the size of the Eustachian catheter employed and the force of the blast of air used. It is also influenced by the presence or absence of swelling or stricture in the lumen of the Eustachian tube, also by the nature of the contents of the middle ear and the mobility of the drum and ossicles. The following modifications of sounds may be easily recognized :

Fluid in the ear gives a fine crepitation ; stenosis of the Eustachian tube a distant and sharp sound ; an abnormally dry ear with a lax membrane an almost rustling sound. In obstruction of the Eustachian tube the stream of air which enters is necessarily small, hence the higher pitch of the sound. Again, a large catheter and a free tube causes a large sound ; while, on the other hand, a fine instrument will give a smaller one.

Diminution of the hearing distance after inflation is an indication not to persist in its use.

Syringing.—The aural syringe should have a capacity of 4 to 6 ounces, and at the present day may be obtained with the plunger, as well as the rest of the syringe made of metal, consequently being capable of ready sterilization by boiling. It should have a nozzle coming to a fine tip, and be provided with two rings attached to the barrel of the syringe for the support of the fingers, as well as with one at the top of the piston-bar. Another improvement is the easy detachment of the nozzle, which enables the syringe to be filled more readily ; the bore of the nozzle must be of large size at its proximal end and be gradually diminished as it approaches the tip, in order to reduce friction.

In syringing the ear for suppurative disease an antiseptic should invariably be used. If, however, the syringing is only for the removal of wax or a foreign body, water is all that is necessary, and the water, or lotion, should be used as hot as the patient can bear it. In the case of a foreign body or a suppurative disease a comfortable temperature is sufficient.

To syringe the ear efficiently the auricle is pulled away from the head and slightly upwards, in order, so far as possible, to straighten the meatus, the syringe having been previously filled and upended, so that any air present in the barrel shall rise towards the nozzle and be expelled by pushing the piston till the water flows steadily. The nozzle is now laid along the upper or posterior meatal wall, and gently but firmly held against it, and the contents of the barrel discharged into the meatus. The stream should always be fairly forcible, and, so far as possible, uninterrupted; if, perchance, air remains in the syringe, the moment it is heard entering the ear, the syringe should be removed and recharged. The careless performance of this simple procedure has often resulted in unnecessary pain and injuries to the meatal wall and drum, accidents which are avoidable, and not to the credit of the surgeon. The patient should always be seated while the ear is being syringed for whatever purpose.

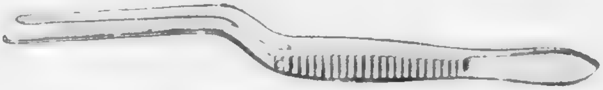

FIG. 24.—AURAL FORCEPS FOR CLEANSING THE EAR WITH COTTON-WOOL MOPS.

After the syringing has been completed, all moisture should be removed from the external meatus by means of pledgets of cotton-wool.

When the ear is syringed for the removal of pus, it is an excellent method to attach a piece of fine indiarubber tubing to the nozzle of the syringe; by introducing the rubber tube deep within the canal the stream of water may be brought directly into contact with the recesses of the meatus and the middle ear both quickly and painlessly.

The Pneumatic or Siegle's Speculum.—This instrument consists of an aural speculum with the addition of a metal cylinder, across the outer end of which a piece of glass is fixed either horizontally or obliquely. The cylinder is attached to a piece of rubber tubing communicating with an arrangement whereby the air within the speculum is subjected to an increase or diminution of pressure at will. It is a good plan to connect this tube with a Delstanche's raréfacteur, this being easier to manipulate than a rubber bag. The instrument possesses three differently sized endings to fit variously sized meatuses, and it is often possible to obtain a closer apposition of the instrument to the walls of the meatus if over the end of the speculum a small piece of indiarubber tubing is drawn. Its use is to enable the surgeon to estimate the relative tensions of the various parts of the membrane, to detect adhesions of the membrane to the structures beneath, and to determine the amount of mobility possessed by the malleus. In employing the instrument the largest speculum that can be made to enter the meatus is chosen.

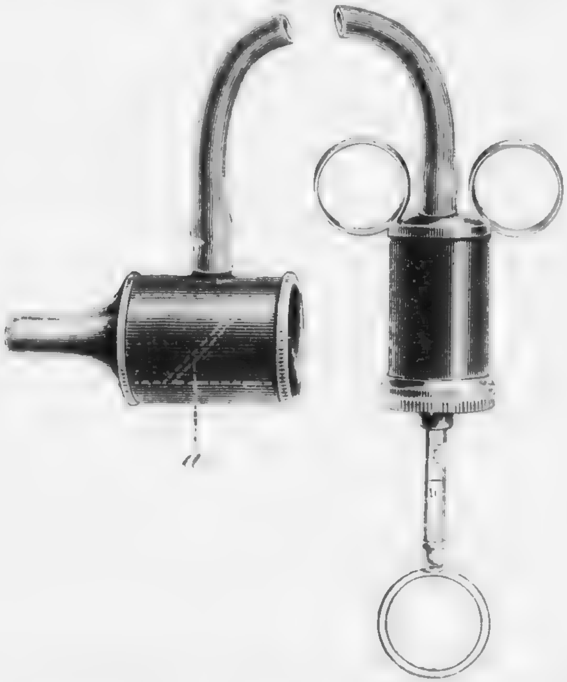

FIG. 25.—SIEGLE'S PNEUMATIC SPECULUM ATTACHED TO DELSTANCHE'S RARÉFACTEUR.

a. The oblique glass-plate.

After the air has been exhausted from the raréfacteur. or rubber bag. the speculum must be gently introduced into. but must tightly fit, the meatus. Having well illuminated the membrane. the raréfacteur. or bag. is allowed partly to refill. which it does at the expense of the air in the speculum and meatus. The eye will then detect any movement in the membrane itself. especially if the bag. or raréfacteur. is frequently and rapidly compressed and relaxed. The detection of immobility of the malleus is much more difficult, and requires a by no means small experience to eliminate error. In order to gauge the extent of the range of movement of the malleus. the speculum must be so adjusted that the tip of the malleus or its short process appears projecting slightly beyond its edge. Having carefully obtained one of these points. especially in the position named. rapid variation of the air-pressure within the meatus will. if the malleus is possessed of mobility. alter the relative position of the point to the edge of the speculum. By no other means is it possible to state with accuracy that the malleus is immovable, for the laxest part of the membrana tympani is the posterior superior quadrant ; should the malleus be retracted, as it often is when morbidly fixed, the least suction outwards of this part of the membrane will give a false impression—the belief that the malleus has moved, when in reality nothing of the sort has occurred. This fact will be more easily understood when it is recalled that the membrana tympani is not intimately attached to the handle of the malleus in its upper half. and thus the thickened tympanic tissue lying external to the mallear handle takes part in all movements of the drum without of necessity communicating them to the malleus.

The Nasal Douche.—For this purpose either an ordinary nasal douche or straight glass syringe is sufficient. The use of such a straight glass syringe has the advantage of being a less forcible method. and where the nose is at all obstructed there is less likelihood of causing the entrance of the fluid into the middle ear ; it is clearly superior to rubber syringes on account of cleanliness. Patients should always be directed to insert the syringe into the nostril which is the narrower or more obstructed, as the pressure will then be reduced in the naso-pharynx. The flow of the fluid is kept directly backward when the point of the syringe is maintained in a horizontal position; if it points upwards, fluid is sent into the middle meatus, and very frequently severe headache is produced. The fluid should be warmed to such a temperature as is most comfortable to the patient, and only sufficient force employed to insure a return flow by way of the other nostril. The nasal douche is in reality a siphon. The vessel containing the solution should be placed about 12 inches only above the head of the patient; otherwise the force obtained may be too great, and the danger of entering the middle ear by way of the Eustachian tube incurred.

Bougies.—It is at times necessary to use a bougie in order to dilate constrictions within the Eustachian tube. There are two varieties of Eustachian bougies—one formed of gum elastic over linen web, which may be used without risk; the other of celluloid, which are scarcely safe in the most skilled hands. Such strictures lie within the cartilaginous portion, and as the catheter itself enters the tube for a short distance, it is quite sufficient for the bougie to be passed ¾ inch beyond the nozzle of the catheter. This distance is controlled either by markings already on the catheter or by first marking on the bougie the length required for it to occupy the whole length of the catheter, and then adding a mark ¾ inch further on. Before employing the bougie, the surgeon must first ascertain that the catheter is correctly placed by inflating the ear. The dilator is then passed, and retained *in situ* from two to five minutes, after which a gentle inflation may be employed, in order to ascertain the effect produced. But if the operator is under any apprehension that he has pricked the mucous membrane of the Eustachian tube, no subsequent inflation should be employed for fear of causing emphysema of the tissues.

Lucae's Probe.—Lucae's probe is an instrument for the application of direct and intermittent pressure to the short process of the malleus, in order to increase its mobility in those cases where, from catarrhal adhesions, the handle of the malleus has become more or less fixed and limited in action. It has at its distal extremity a small steel cup coated with a solution of gutta-percha and allowed to dry. The probe itself is received into a hollow handle and works on a small spiral spring, which gives the necessary force required for restoring the lost mobility. Before proceeding to employ this method of treatment cocaine is applied to the drum, using either a 20 per cent. aqueous solution or Gray's aniline oil solution, the latter having greater power of penetration. Unless the drum is anæsthetized in this way the treatment is very painful. The head of the probe is applied under reflected light to the short process of the malleus, and pressure is maintained for a period not exceeding two minutes ; this application is repeated daily for ten or fourteen days, according to the amount of benefit derived. A probe of somewhat similar form, but having no spring, is employed for the purpose of forcibly mobilizing the malleus, which little operation is performed under an anæsthetic.

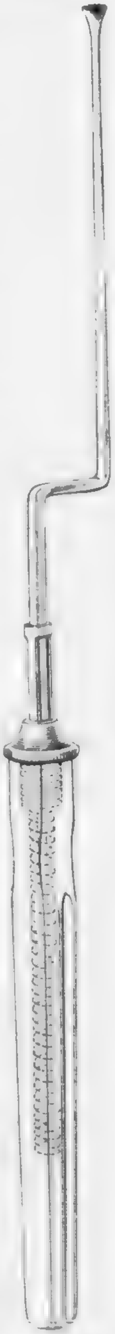
FIG. 26.—LUCAE'S PROBE.

Air-Massage or Pneumo-Massage.—The aurist has three separate means of employing pneumo-massage at his disposal—the finger, Delstanche's instruments, and the manual or electro-motor oto-masseur.

In employing the finger for massage the patient presses the tragus backwards so as to cover and shut the orifice of the external meatus, which little manœuvre is repeated rapidly for several minutes, using as much pressure as possible when closing the meatus in order to raise the intrameatal pressure.

The instruments of Delstanche are provided with a rubber tube terminating in a conical ear-piece, which is inserted into the external meatus, and then by alternately compressing and releasing the piston variations in pressure are produced. This method should not be employed for more than twenty seconds at a time to commence with. The period may be slowly increased with safety to as long as five minutes, and may be repeated several times daily.

The hand-machine shown in Fig. 27 will give 2,000 revolutions per minute when driven at its greatest pace.

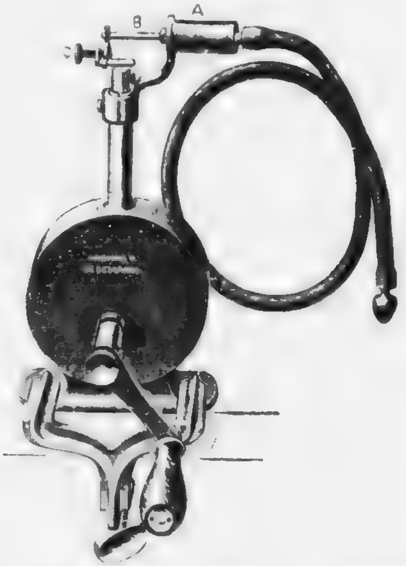

FIG. 27.—OTO-MASSEUR, HAND-MACHINE.

The tube should be of metal.

When the electro-motor-driven masseur is used the length of time must be carefully observed, commencing with half a minute daily, and increasing to a maximum of two minutes. With these instruments it is of great importance that the length of the piston-thrust be not over ⅓ inch. Those usually sold are too long for ordinary use.

Electrically-driven instruments giving high rates of speed are to be obtained, and yield better results.

The following rules may be laid down as to the employment of oto-massage other than Delstanche's method :

1. A positive Rinne is an absolute contra-indication, unless there is a fixed malleus.
2. *Fixed Malleus.*—Whatever Rinne's test shows, but with a positive, caution is requisite.
3. All forms of ear trouble giving double negative Rinne.
4. In no form of suppurative disease should it be employed.

Artificial Drums, Aids to Hearing, and Sound Deadeners.

Artificial drums are sometimes of assistance when there is perforation, or even complete destruction of the tympanic membrane, in cases where the membrane is more or less adherent to the inner wall of the tympanum, and at times when the malleus is immovable. They are either made of rubber discs or of cotton-wool. The former are either made with a wire stem, or with a thread attached. The wool artificial drums may be compressed and cut into discs; these when fixed on a wire are known as Toynbee's, and if to a thread as Field's, or the wool may be rolled tightly into the form of a round wick, with its ends cut off or folded over and compressed so as to leave it about $\frac{3}{4}$ inch long. Both forms should be tried dry, or slightly greased with vaseline.

Before using any form of artificial drum, all suppuration must have ceased for at least four weeks. The rubber disc must be trimmed with scissors to fit the perforation, moistened with a little dilute glycerine and water rendered antiseptic. The woollen wick is introduced with forceps and Grüber's drum by a special carrier (Fig. 54). The hearing must be tested before and after applying the drum, and slight alterations made in its direction until the best possible result is obtained; these foreign bodies are not to be employed for more than an hour daily for the first fortnight, in order to accustom the ear to their presence.

The various forms of ear-trumpet and of vulcanite fans applied to the teeth and obtainable from instrument-makers are of variable use, and the best plan is for the patient to go and try them, selecting some for a more extended trial at home.

The modern varieties of portable telephones are so numerous that one cannot enumerate them. but they are of the greatest value. especially to those who suffer from otosclerosis.

Sporting men frequently require protection for the ears, either from the wind in hunting or from the continual shock of gun-firing in covert shooting. Naval and military men who are frequently exposed to the continuous discharge of artillery should stand with the face towards the muzzle of their piece or pieces, and keep the mouth a little open. During practice Hawksley's clay is to be much recommended. The same protection from noise is at times required when the auditory nerve is hypersensitive ; or for this purpose small vulcanite sound deadeners may be employed.

SCHEME FOR RECORDING TESTS.

Name............................ *Date*................

RIGHT.	TESTS.	LEFT.
Mobile	Malleus	*or Immobile*
ft. *ins.*	Acoumeter	*ft.* *ins.*
ft. *ins.*	Voice	*ft.* *ins.*
ft. *ins.*	Whisper	*ft.* *ins.*
Positive or negative	Rinne C Rinne C^2 *	*Positive or negative*
Normal + or − seconds	Bone-cond^{n}. or C. on Mastoid	
	Galton Whistle	
Positive or negative	Gellé	*Positive or negative*
	Air-cond^{n}	
Absent, normal, or minus seconds	3C(16) 2C(32) 1C(64) C(128) C^1(256) C^2(512) C^3(1024) C^4(2048) C^5(4096)	
	Paracusis Willisii	

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* When both of these are negative, it is called 'double-negative Rinne.'

CHAPTER VI

THE EXTERNAL EAR—MALFORMATIONS, INJURIES, AND DISEASES

Malformations.

THE more usual malformations of the external ear consist either in an increase of size, or in deficiencies due to an arrest of development of the auricle—defects which vary on the one hand from quite small rudimentary nodules, situated in the position usually occupied by the pinna, and only containing a diminutive fragment of cartilage, to, on the other, any possible alteration from the normal in size and shape. Amongst the more common abnormalities may be noted the so-called supernumerary auricles, which may take the form of additional projections in the neighbourhood of the tragus, or may be situated in the neck at the site of the lower branchial clefts. These are of no importance, except from an æsthetic point of view (Fig. 28). When there is marked loss of development of the external ear, the external meatus is usually absent, or replaced by a small cul-de-sac, and there is no connection between it and the middle ear (Fig. 29). Another not infrequent deviation from the normal is the eversion of the concha (Fig. 30).

Plastic operations for the relief of deformity may be undertaken, but no precise directions can be laid down for guidance, as in those instances where operation is decided upon, each case must be dealt with as its own peculiarities demand. It is generally useless to attempt to restore the external meatus, as there is in these cases bony occlusion of the canal beyond the end of the membranous cul-de-sac. Excellent artificial ears may now be obtained from instrument-makers.[*]

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[*] Or from Mr. H. Brooks of Halifax, Yorkshire.

The surgical treatment of protruding ears may be either confined in children to the use of straps, caps, and the like, which should be constantly worn, or operative measures may be undertaken. A vertical segment of skin and cartilage, with its base wider in the middle than at the ends, is dissected out, and the wound sutured with silver wire or silkworm gut, drawing the cut surfaces of the cartilage and skin well into apposition. The ears are to be held back by a bandage for at least four weeks afterwards. Or the following operation will be found extremely serviceable both in reducing their size and in correcting their deformity. A curved incision is made on the back of the auricle, with its apex just in the post-auricular fold, rather above the top of the concha, and terminating below in the same fold at the bottom of the concha, the convexity outwards of this line of incision being in exact relationship to the amount of correction necessary.

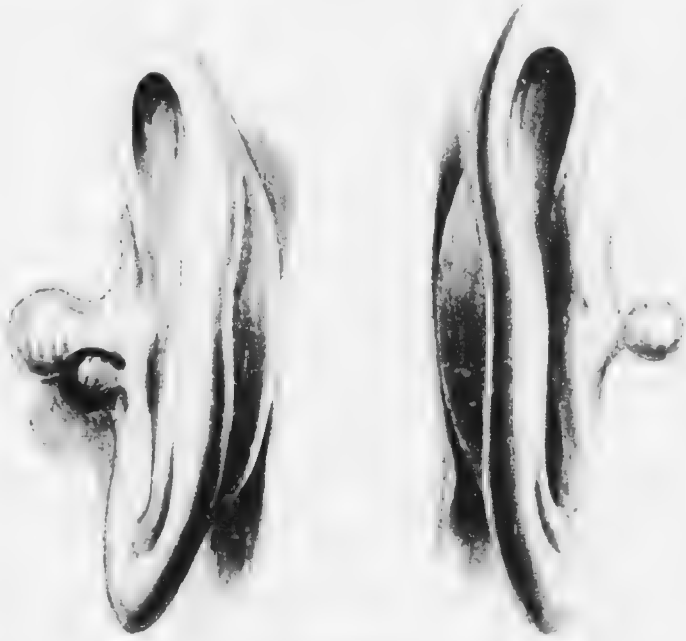


FIG. 28.—SUPERNUMERARY AURICLES

After the removal of the skin enclosed between these incisions, a second curved incision is made, terminating in the same points, through the skin on the bone behind the ear. This again must be curved, with its convexity backwards, and must also be commensurate to the deformity. An elliptical piece of the cartilage is now removed, the auricle is held forward, and the cartilage is divided on to the finger, taking care not to penetrate the skin, which the presence of the finger should readily prevent. The cartilage is then separated from the skin with the handle of the scalpel, and the free portion removed. A single buried suture may be employed to bring the two edges of the cartilage into apposition ; the skin will then be carefully closed with sutures, and the wound dressed. If there is no bleeding, a collodion dressing may be employed, but it is usually better, if there is any oozing at all, to wait twenty-four hours before its application. It is well to let the patient wear a webbing bandage for two or three weeks after the operation. The results of this operation are surprisingly effective.

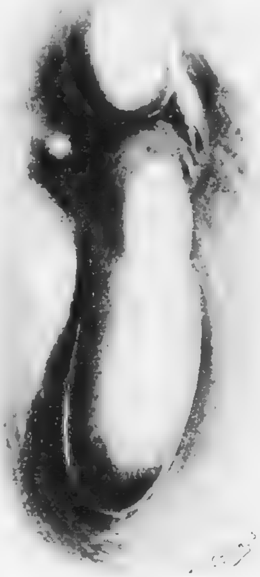


FIG. 29.—MAL-DEVELOPMENT OF EXTERNAL EAR.

Injuries.

Frost-Bites.—The part affected, usually the tip of the ear, if seen early, is found to be dead white and absolutely insensitive. A marked degree of redness in the adjoining portion of the pinna is soon noticed, and in the course of a few days the area becomes black, and is ultimately thrown off. Superficial sloughing of the skin is very commonly found as the result of slight frost-bite amongst people exposed to severe weather—milkmen, drivers, etc.

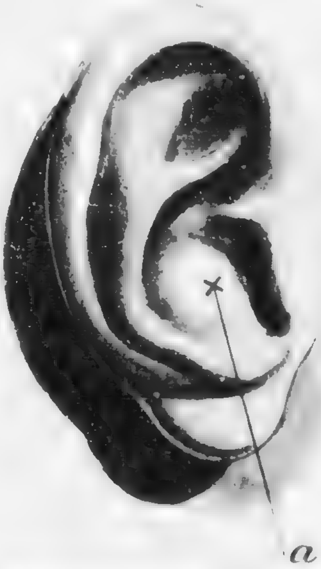


FIG. 30.—MALFORMATION OF EXTERNAL EAR.

a, Eversion of concha.

Treatment.—In the first instance, the best procedure is to attempt the restoration of the circulation, which is best done by hand frictions with snow, the return of circulation being heralded by a severe burning pain. Should a sphacelus have formed, a dry dressing of iodoform and cotton-wool should be employed, and no undue haste need be exhibited in removing the dead tissue so long as proper antiseptics are employed.

Chilblains.—This troublesome complaint frequently affects the ears, and requires the same local and general treatment as chilblains in any other part of the body.

Hæmatoma Auris.—The traumatic effusion of blood that takes place in the tissues of the external ear is situated in the majority of cases beneath the perichondrium, and the region involved is most frequently the upper posterior quadrant of the external surface; it is common in pugilists and football players, and is almost invariably due to direct violence. A similar condition is liable to be produced by very slight trauma, or to be aroused spontaneously in patients suffering from insanity. The skin covering the tumour appears of a dusky purple hue, being rarely normal in colour. The temperature of the part is slightly increased and the tumour has a boggy feeling, unless the blood has been suffused into the subcutaneous areolar tissue, when fluctuation is more marked.

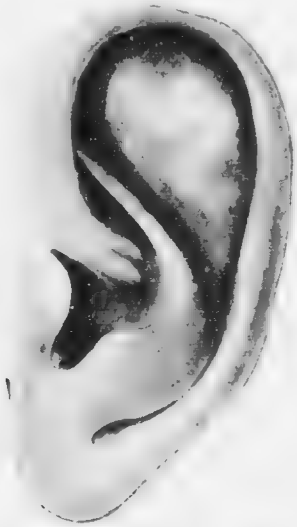


FIG. 31.—HÆMATOMA AURIS.

TREATMENT.—It is important to note that resolution is not certain to take place, but that if it does deformity is sure to result. For these reasons, and also on account of the safety afforded by the use of antiseptics, free incision of the tumour with evacuation of its contents should be undertaken immediately in all cases, the incision to extend from the top of the tumour to the bottom. All the blood-clot must be carefully removed, if necessary with the aid of a blunt spoon, and the interior of the cavity cleansed with sterilized or antiseptic swabs and dried. The wound may then be sewn up in its entire length, and firm pressure applied by means of a bandage, so that the auricle be held firmly against the head.

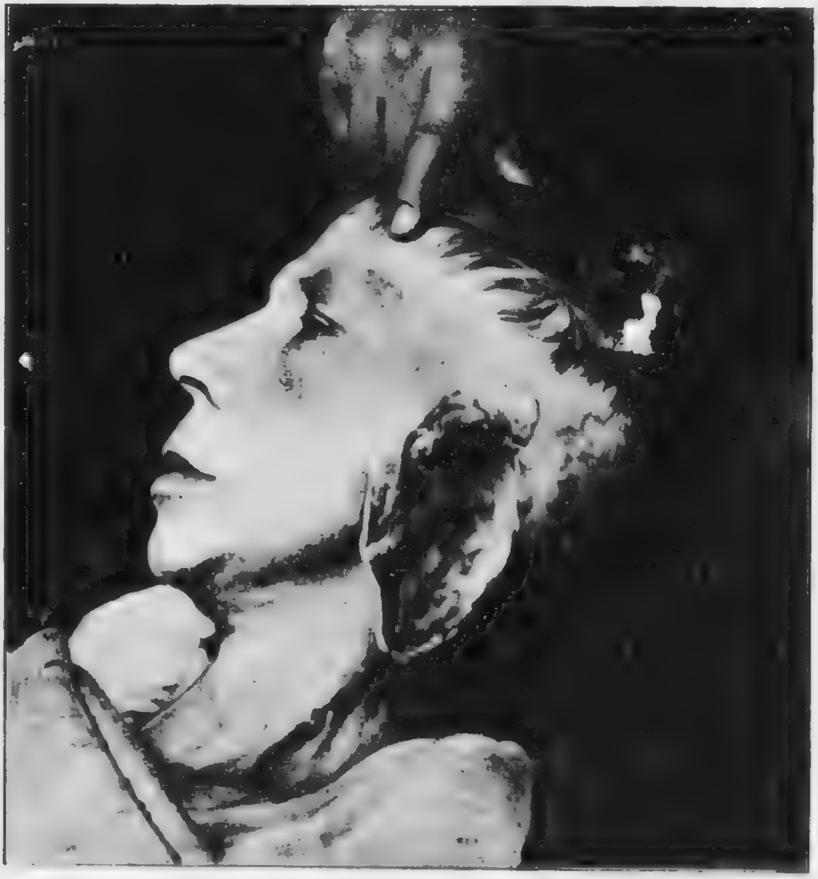


FIG. 32.—RODENT ULCER OF EXTERNAL EAR.

Should, however, the patient refuse the rapid cure to be obtained by this method of treatment, the blood may be removed by means of an aspirator, and a dressing of collodion and gauze applied over the whole ear in order to obtain a fair amount of pressure, which may be supplemented by a bandage.

If the tumour be not of recent date, and there is already alteration in the cartilage, the serum, which will have separated from the clot, should be removed by means of an aspirator, and a cure attempted by pressure. If, however, reaccumulation occur, incision and scraping out of the cystic cavity affords the best prospects of success, or a little tincture of iodine may be injected.

Diseases of the External Ear.

The more usual diseases affecting the external ear are herpes, eczema, erysipelas, perichondritis, formation of cysts in the auricle, and new growths. Of the latter, papillomata (Fig. 33), rodent ulcer (Fig. 32), epitheliomata of the auricle, and fibromata of the lobule, are the commonest varieties, and sarcoma one of the rarest.

Herpes of the ear possesses no feature to distinguish it from herpes in other parts of the body. Similar treatment must be adopted.

Acute Perichondritis of the External Ear.—This condition is, fortunately, rare, and it is always of a septic origin. It is found in neglected cases of furunculosis, and less often in cases of chronic middle-ear suppuration; and it has also been known to follow a mastoid operation when, for want of proper attention to antiseptic treatment, the cartilage has become infected.

The ear becomes generally thickened, smooth and glistening, gradually becoming of a dusky colour, tense and hot to the feel. The body temperature will be raised a few degrees, and the pulse quickened. If the perichondritis is due to a septic injury, the immediate course to pursue is to promptly open up the wound, and by means of free incision to expose and remove as far as is necessary, and as far as is possible, all infected tissue. When the cause of the perichondritis is extension from a furunculosis of the meatus, the furuncle must be freely opened, sinuses followed up, and all diseased tissue curetted. But whichever of these two preliminary treatments is adopted to remove the focus of infection, the treatment of the auricle itself does not vary. After thoroughly cleansing its surface, best with iodine dissolved in spirit of chloroform, or 5 per cent. thymol in alcohol, the ear is punctured in six or seven places with a fine scalpel, passing completely through the ear, and then a moist antiseptic dressing should be employed and frequently changed. Or the ear may be smeared over back and front with unguentum hydrargyri, and then dressed with a warm moist dressing, covered by protective and cotton wool. This dressing wants changing two or three times a day. During the illness, tonics and a stimulating diet are required, and in adults probably a little red wine.

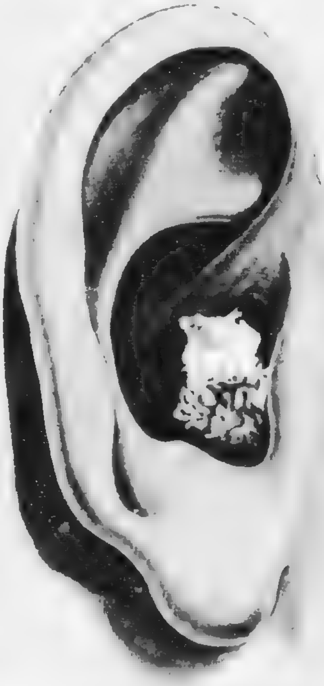


FIG. 33.—PAPILLOMA OF EXTERNAL EAR.

Abscess of the Lobule.—Abscess of the lobule is by no means an uncommon ailment as the result of an acute inflammation of a pre-existing cyst, in most cases dermoid in origin, though occasionally it may be sebaceous, or the result of a puncture of the lobule made to enable the individual to wear earrings, when this is done with a dirty needle or afterwards becomes infected.

Acute eczema is best treated by the use of a powder of oxide of zinc and starch, made up in equal parts, or by any of the soothing ointments, such as oleate of zinc, 15 per cent., etc. Goulard water is a good application in the weeping forms.

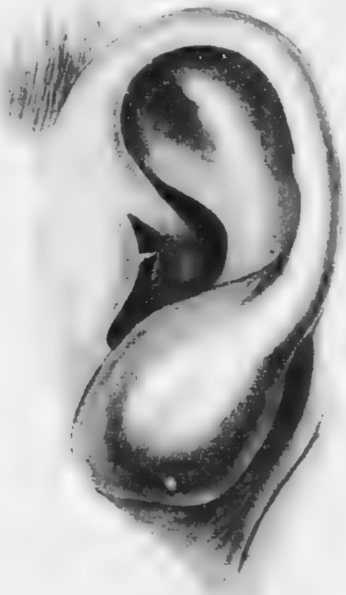


FIG. 34.—SUPPURATING CYST OF LOBULE.

If, however, the disease is chronic, the skin of the part is much thickened, and from subacute exacerbations of the inflammation the auricle often becomes a shapeless mass, giving rise to much discomfort both from the pain and irritation which accompanies it as well as from the discharge.

The same treatment must be carried out as for an acute condition, but as soon as the sharpness of the inflammation has subsided, the use of Hebra's diachylon ointment is a most valuable help. The ointment is to be well rubbed in with massage of the part several times daily, while at night the ear should be wrapped up in a piece of linen spread with the ointment. (Also *vide* Appendix.)

Eczemas here, as in any other part of the body, will often prove intractable to any one treatment. Strong solutions of nitrate of silver, 30 grains to the ounce, have been recommended as a treatment in the form of a paint when the external meatus is involved. Internal treatment in childhood consists in administration of tonics, in adults of antilithics.

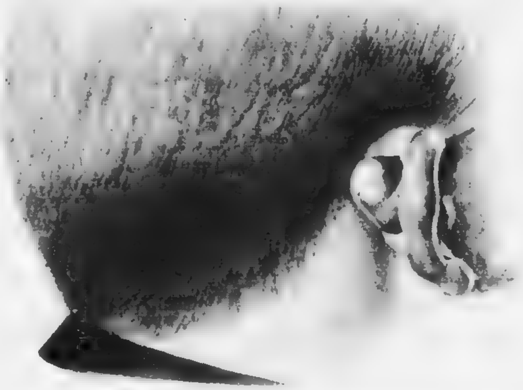


FIG. 35.—RETRO-AURICULAR DERMOID CYST.

New Growths of the External Ear.—With the exception of the fibrous tumours of the lobule, these tumours require no special description, as they possess no features peculiar to their situation.

The fibromata of the lobule are in reality keloids, and follow the wearing of earrings. When these enlargements become unsightly they should be removed, together with as much of the lobule as is necessary to obtain their complete excision, since if any part of the tumour remains it is extremely likely to recur.

The serous cysts of the auricle to which we have referred are found in much the same position as the othæmatomata—that is to say, the fossa triangularis. They are, however, spontaneous in origin, the temperature of the part is not raised, the superlying skin is normal in colour, and they are merely pink to transmitted light; whereas in the case of othæmatomata light is transmitted very badly.

The treatment of these little cysts is incision and free scraping out, followed by antiseptic packing for a few days. If a cutting operation is for any reason undesirable, the fluid contents of the cyst may be withdrawn by aspiration, and a few minims of tincture of iodine injected into the cavity. The auricle should be protected by cotton-wool until the inflammation caused by the injection has subsided. Cysts of the lobule are not uncommon, and are either dermoid or sebaceous. They frequently suppurate, but merely require dissecting out (Fig. 34). Dermoids cysts also occur behind the auricle.

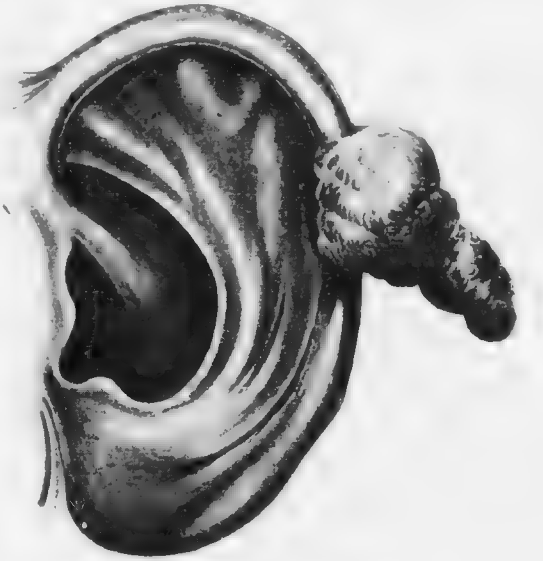


FIG. 36.—HORNY GROWTH OF AURICLE.

Sarcomata of the external ear are very rare, and there are not many on record. When they do occur, they may take the form of a fleshy growth, resembling a polypus, springing from some part of the concha ; this moves freely to the touch, and is not usually very painful. Here, again, a free removal, probably including the whole of the external ear, may prove quite satisfactory. If this is done, the raw area should be covered with a Thiersch's skin graft. Afterwards the disfigurement can be remedied by the employment of an artificial auricle.

EXTERNAL MEATUS

Acute Diffused Inflammation of the External Meatus presents itself either as an extension of similar disease involving the pinna, such as erysipelas or acute eczema, or it may be confined to the external meatus, as in acute eczema or acute gouty dermatitis ; on the other hand, it may have extended from the middle ear when that is acutely inflamed. If this diffused inflammation is merely an extension of an erysipelas of the surrounding parts, it presents no difficulty of diagnosis, and its treatment will vary in no way from that employed for the original disease, beyond the insertion, after all acute signs are abated, if required, of plugs of sterile gauze into the meatus in order to restore the calibre to its normal dimensions. In acute eczema of the external meatus, where it is confined to the meatus or has spread from the pinna, a watery exudation is formed which flows from the ear. This discharge will, if the external meatus is not regularly and thoroughly cleansed, soon become offensive, though rarely purulent, and is the condition often known by the name of otitis externa. The external meatus will be much reduced in size by the swelling of its walls, and an inspection of the deeper parts made difficult or impossible. In rare cases the swelling may extend over the mastoid process and resemble an acute mastoiditis.

SYMPTOMS.—One of the chief symptoms in a large proportion of mild cases is a watery, odourless discharge from the external meatus, though it is sometimes cloudy and offensive ; pain and a sense of fulness of the ear, when discharge will be scanty or absent ; redness, swelling, and an inflammatory occlusion of the external meatus are frequent accompaniments. In recurring cases there is a tendency to permanent contraction of the canal. Vesicles and pustules are rarely discernible in the meatus. In the deeper parts of the canal sodden epithelial cells collect. The patient complains of pain, deafness, much itching, and of a sensation of heat in the canal. In children this variety of eczema is frequently impetiginous, whilst in adults it is usually of gouty origin, and may be associated with eczema of other parts. In chronic eczema the discharge is usually less, though more often offensive. In these cases the canal is often permanently occluded through the formation of fibrous tissue in the deeper layers of its lining membrane. Irritation is more troublesome than pain, and in certain instances discharge is absent. The eczema is then of a dry, scaly character, and there is no consequent contraction of the canal.

TREATMENT.—The constitutional treatment of this disease in children is the administration of iron and cod-liver oil, with the occasional exhibition of rhubarb and soda or hydrarg. c. creta at night ; wholesome food and an open-air life materially assist in combating the trouble. In adults a careful attention to the dietary, with restriction of alcoholic beverages, more especially of beer and sweet wines, together with a prolonged course of citrate of lithia and the regular use of saline aperients, constitutes the most appropriate treatment.

Local Treatment.—In children suffering from an impetiginous eczema, the use of dilute ammoniated mercury ointment is indicated, which is to be applied to the whole of the affected surface once or twice daily by means of a pledget of cotton-wool wrapped round the end of a small probe ; and as an alternative treatment boracic ointment will often be found serviceable. In adults, oxide of mercury ointment 8 grains to the ounce of vaseline, is used in the same way in the less acute cases ; and as an alternative treatment dilute ammoniated mercury or boracic ointment is useful, and in very acute cases zinc and starch powder. In all cases the canal must be syringed out from time to time with weak warm boracic solution, 5 grains to the ounce, in order to remove shed epithelium, irritant secretion, and superfluous ointment. The tendency to contraction of the meatus in both acute and subacute cases may be checked by the insertion of indiarubber tubes as large as can be introduced into the external meatus. These must be frequently changed, as the greasy matter which forms the basis of all ointments will soon render them soft and useless. By stretching the canal, and by pressure, these tubes help to disperse the inflammatory material present in the subcutaneous tissues, and at the same time they enable the surgeon more easily to apply his remedies and inspect the deeper parts. Thickening of the membrana tympani will cause a certain amount of dulness of hearing.

In the treatment of acute inflammation which has extended from the middle ear, plugging the canal with a strip of sterile or iodoform gauze will be all that is necessary; and if, as occasionally happens in these cases, small bullæ containing clear or sanious fluid are found, they should be punctured before the gauze is introduced.

Collapse of the Mouth of the External Meatus is a condition found exclusively in elderly people, and is due to senile changes in the tissues, which result in a vertical closure of the orifice of the external meatus, the posterior wall falling forwards. This closure of the meatus renders the patient very deaf, but is a condition which is easily corrected by introducing into the meatus a small piece of indiarubber tubing about ½ inch in length, and of as large a diameter as possible. Usually this may be removed after being worn for a few weeks, but the tube must, at any rate, be retained as long as is necessary, although it may be taken out and cleansed as often as is desired.

Otomycosis.—Certain fungi are not infrequently found, especially in the deeper parts of the external meatus, and particularly occur in the inhabitants of damp climates or insanitary dwellings. They are a common trouble to residents of subtropical regions. The more usual fungi are the *Aspergillus niger vel albus*, or one of the mucors.

COURSE AND SYMPTOMS.—The disease commences with an irritation in the external meatus, gradually becoming more intense and persistent, and, in occasional cases, a certain amount of eczematous discharge is present. The hearing may become affected, and pain is at times complained of. The disease tends to temporary remissions, but not to spontaneous cure. On examination of the ear, patches are noted in the deeper parts of the meatus, either of a dirty black or of a white or red colour, according to the particular fungus which is present. These discolorations may be surrounded by patches of inflamed tissue, or be accompanied by a free desquamation, which, when removed, will often show the fungus to the naked eye. The final and differential diagnosis must be made by the aid of the microscope, a small portion of the growth, removed either by the forceps or by the curette, being subjected to examination.

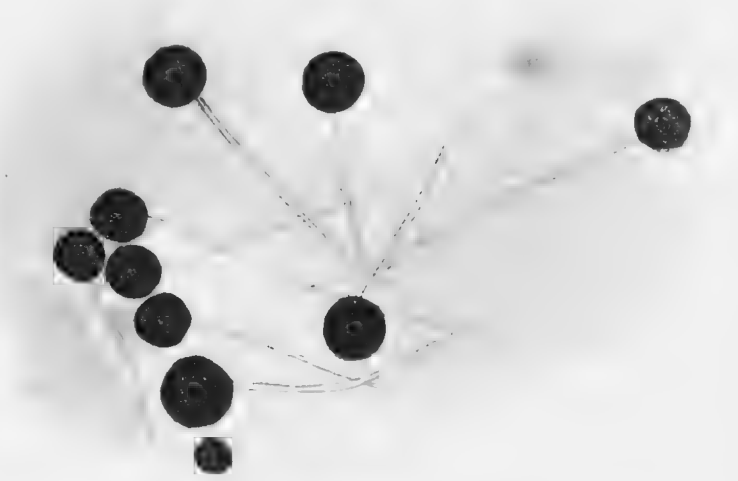


FIG. 37.—ASPERGILLUS NIGER FRUIT.

Treatment.—The ear should be well syringed with warm boracic lotion, and any visible patches which cannot be so removed cleared away by means of a blunt scoop or the forceps. Alcoholic drops are to be instilled into the ear once or twice daily. The efficacy of a spirituous lotion for this purpose is increased if it contain a small amount of camphor, oil of cinnamon, one part per thousand of corrosive sublimate, or five parts per hundred of salicylic acid. The drops should not be continued for a longer period than four to six weeks without intermission, nor should they be persisted in if they cause irritation of the canal; in the latter case a mercurial ointment, applied in the way previously described, is to be used until all the symptoms of irritation have disappeared, or an insufflation of powdered boracic acid may be employed.

Herpes of the External Ear and Meatus.

Herpes, when occurring in the meatus, and whether it affects the drum or not, has very much the same characteristics as elsewhere—a burning sensation followed by pain as the vesicles develop. When the tympanic membrane is involved, pain and deafness supervene. If possible, the vesicles are to be painted at their earliest appearance with a little collodion. After the commencement of suppuration, however, a soothing ointment is advisable, and aspirin is to be administered.

Circumscribed Inflammation of the External Meatus: Furunculosis or Abscess.—This kind of abscess, or boil, of the external meatus is of the nature of an infective inflammation involving one of the ceruminous glands and the surrounding tissue, and at its earliest stages it does not exceed in size that of a millet-seed.

Causation.—An examination of the micro-organisms found in the external meatus of apparently healthy people commonly reveals the presence of *Staphylococcus albus* or *aureus*, and it is to the entrance of one of these into the glands when the general health of the patient is somewhat impaired that the furunculosis is due, though it is probable that there is frequently in addition some previous slight inflammation of the canal. Occasionally this predisposition is caused by the presence of the aspergillus, by a discharge from the middle ear, or by the careless use of chromic acid or other powerful therapeutic agent.

Course and Symptoms.—The first symptom is that of irritation within the canal, followed by a shooting or throbbing pain, becoming of a very severe character, keeping the patient awake at night and causing an amount of constitutional disturbance entirely out of proportion to the severity of the local disease. The pain is increased by pressure on the meatus and by mastication, and glandular enlargement may be noted in front of the tragus or over the mastoid process. The pain is followed by discharge of a small amount of pus, thick in character, with partial relief of the pain. As one abscess subsides another frequently appears, and this condition may persist for several weeks. The temperature is scarcely elevated in adults. Occasionally the abscess, even after rupture into the lumen of the canal, increases in size and penetrates the deep tissues, and, passing outwards beneath the cartilage, forms an abscess over the mastoid process, thence burrowing downwards in the direction of the sterno-mastoid muscle, and when thus presenting behind the pinna the abscess causes objective symptoms extremely similar to those caused by a subperiosteal collection of pus due to acute disease of the mastoid process. The furuncle is usually situated on the upper or posterior wall of the canal, more rarely on the anterior. When this abscess or furuncle is situated over the anterior wall, the parotid lymphatic glands are often involved, and if the pus penetrates through the deeper tissues, it forms a superficial abscess in the parotid region. If the abscess has penetrated the deeper tissues of the meatus the canal will be occluded, and pressure over the external swelling may cause pus at times to well out from the canal, though this observation is of no diagnostic value.

Objective Symptoms.—When furunculosis of the canal is suspected, a preliminary examination should be made without the use of a speculum, so that if the abscess be situated close to the external meatus, the pain occasioned by the introduction of a speculum may be avoided. If, however, the suppurating point is not visible, a speculum must be introduced, and with whatever care this may be done, a certain amount of pain and discomfort is almost unavoidable. On inspection, it will be observed that in the canal and its external half there is either a distinctly tender spot situated at a slight depth from the surface, or there may be only an indefinitely marked diffused swelling. If the abscess has already ruptured, there will be a small point from which a minute quantity of pus exudes.

TREATMENT.—A free incision carried deeply through the centre of the abscess is the best treatment. This should be done if possible under the influence of a general anæsthetic, though the use of Gray's cocaine solution (Appendix) will to a large extent annul the pain, should chloroform or nitrous oxide gas not be advisable. Previous to incision, the canal should be thoroughly irrigated with either a strong antiseptic solution, such as 5 per cent. carbolic acid, or with peroxide of hydrogen 10 volumes. The contents of the abscess cavity are evacuated and its walls well scraped with a curette, and a plug of gauze soaked in 5 per cent. carbolic acid used as a light packing. This treatment tends to prevent recurrence of the affection. The dressings should be changed every twenty-four hours, the canal being first irrigated with peroxide of hydrogen, and afterwards with 5 per cent. carbolic acid solution. To control the pain it is frequently necessary to resort to the internal administration of morphia, while according to some observers, the tendency to recurrence may be partly checked by the administration of calcium chloride. To ease the pain, if incision is not resorted to, hot antiseptic fomentations should be applied every four hours, or aural ovoids containing opium may be placed in the meatus, or chloroform vapour locally will give temporary relief (see Appendix).

Ulceration of the External Meatus.—Superficial ulceration of the external meatus either follows abrasions of condylomata or is a separate secondary symptom of syphilis. The employment of lotio nigra or calomel dusting will be found very efficacious in such cases.

Diphtheritic or Croupous Inflammation of the External Meatus.—The external meatus may be the seat of diphtheritic inflammation, and it can usually be traced to the entrance of foul water into the ear, as, for instance, after bathing in a dirty stream. The deeper parts of the meatus especially are covered with a false membrane of a white or yellowish white hue, which, when detached from the skin, occasionally leaves a raw surface.

Treatment.—The canal should be frequently irrigated with a solution of perchloride of mercury, 1 in 2,000, or a 20 per cent. solution of lactic acid. Alcohol may be instilled into the ear in the intervals between the irrigations. The external meatus is afterwards plugged with antiseptic gauze soaked in corrosive sublimate or lactic acid of the above strength.

Bony Growths.—Bony outgrowths in the external meatus are either diffuse or circumscribed.

The Diffused Bony Outgrowths of the External Meatus, or the so-called hyperostoses, consist of a more or less annular outgrowth of bone, which increases gradually and regularly and contracts the meatus eventually down to an extremely small calibre (Fig. 38). They are caused either by an irritation set up by discharge or by some other form of irritation, such as a gouty eczema of long standing. The outgrowth rarely, if ever, entirely occludes the canal. Its progress is slow, but it is not in itself a common cause of deafness; for where the hyperostosis almost occludes the canal and deafness is present, and there is no perforation of the tympanic membrane or discharge from the middle ear, there is usually concomitant pathological change in the deeper parts. When the hyperostosis is caused by irritating discharges from the middle ear, it becomes a matter of urgent necessity that the discharge be entirely and permanently checked, or that a radical operation be performed on the mastoid before com-

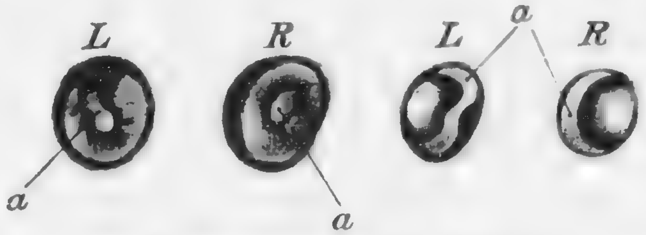


FIG. 38.—HYPEROSTOSES AND EXOSTOSES.

a, Lumen of the canal. The two left-hand figures are hyperostoses; the two right-hand ones examples of exostoses.

plete occlusion of the canal occurs ; for should the exudation be dammed up behind such an obstruction, absorption from pressure will take place, and serious sequelæ may be with certainty expected, either from septic absorption or from extension of the disease to the deeper parts of the temporal bone, and even to the intracranial structures.

Circumscribed Bony Growths, or Exostoses.—These may be compact or cancellous, sessile or pedunculated. The spongy exostosis is of comparatively rapid growth, is single and sessile, and may be situated in any part of the meatus, from its external orifice to the margins of the membrane itself; it is covered by a layer of cartilage. The ivory exostosis is usually multiple, of slow growth, and occurs in the bony meatus. The spongy growth tends to entire occlusion of the meatus, whilst the sessile ivory growths rarely completely obliterate the canal.

SYMPTOMS.—The symptoms are those of occlusion of the meatus—that is to say, deafness and noises in the ear. On examining the meatus, in the case of a sessile growth, the canal is found at this part either reduced to a crescent, and the growth often is of a pearly, semi-translucent hue, smaller or larger according to the size of the growth, or it may be completely occluded by a round tumour of the same colour as the rest of the meatus. If, however, the growths are multiple, the canal is then more central, hour-glass or roughly trefoil in shape, and this small passage is rarely entirely obliterated unless in consequence of inflammatory complication, or from the presence of impacted cerumen or epithelium.

The TREATMENT of these growths is based on the amount of obstruction they cause to hearing. Should there be no middle-ear deafness, and if, when the obstruction is complete, there is no reason to proceed to more radical measures, the growth may be removed with restoration of the hearing-power. As has been indicated, however, there is one marked exception to the foregoing rule, which is that operation should invariably *be undertaken without delay* in those cases where middle-ear suppuration complicates the condition, and the operation should then be that known as the radical mastoid operation, not merely an attempt made to restore the lumen of the canal. Should the occlusion by exostosis be complete, or almost so, especially if both ears are affected, one of the following operations may be undertaken. It ought to be borne in mind, however, that they are extremely difficult and delicate undertakings.

Operation for Spongy Pedunculated Growths.—Should the growth be within easy reach, one may attempt to remove it from the meatus by fracturing the base and twisting the growth off bodily by the aid of a pair of dentist's fang forceps; a strong wire snare is sometimes sufficient. If the surgeon prefer, he may cut through the pedicle by means of a fine chisel and remove the growth by avulsion. Another plan is to deflect the ear forwards by means of a semicircular incision behind the pinna, and having separated the meatus sufficiently to expose the growth, it is removed after cutting through its pedicle with a chisel. Should this method be adopted, the external meatus must be carefully plugged and kept plugged for at least ten days after the operation. When the growth is removed viâ the meatus, the same treatment is to be adopted which will be described as suitable for the ivory or sessile growth.

Operation for Ivory Growths.—The surgeon is here restricted to the use of the dental burr, or chisel, or compelled to deflect the pinna. In using the burr, the object is to remove the growth from the apex towards its base, attempting as far as possible to restore the calibre of the meatus to its original size. Burrs are to be preferred which have their extremities protected, but a small protector should be passed beyond the growth when the size of the canal permits, in order to protect the drum and middle ear from accidental injury. This kind of protection, however, is impossible in many cases, and the operator is to be guided entirely by his knowledge of the anatomy of the part. He must use his instrument therefore with the greatest care and dexterity. If the chisel is employed, there is no fitter instrument than the dentist's straight enamel chisel; but since the temper of this instrument is very high, it should be drawn by being held in the flame of a spiritlamp until the blade turns to a blue colour when cold. When using the chisel, the growth is attacked near its base, and detached in as large portions as possible, though the manipulation in this, as well as in all other operations, is only learnt by experience. The dangers which are to be borne in mind are injury to the tympanic membrane and ossicles, or division of the facial nerve, by losing control of the instrument at the moment of overcoming the resistance caused by the growth. After the growth has been removed to the satisfaction of the operator, the meatus must be thoroughly cleansed by irrigation with strong antiseptics, and an antiseptic plug inserted, and the case treated with the strictest antiseptic precautions until the healing of the surface is fairly complete. To avoid contraction or stenosis of the meatus it is advisable to insert a leaden tube as large as the lumen of the canal will permit, and it is not infrequently advantageous to commence the insertion of such a tube immediately after the removal of the growth.

Stenosis of the External Meatus may be congenital, post-operative, syphilitic, traumatic, or post-inflammatory. When post-inflammatory, it is commonly the result of suppurative inflammation of the middle ear, and will be described as a complication of that disease. Marked contraction frequently follows chronic eczema, and may be situate at the external orifice or in the cartilaginous parts ; in elderly people there is often noticed a falling in of the cartilage leading to a partial occlusion.

TREATMENT.—Acquired webs should be dissected away by means of a circular division of the tissue close to the meatal wall ; a rubber or metal tube is then inserted, and should be of as large a size as possible. This is only removed at intervals for the purpose of cleansing the meatus for at least four to six weeks ; nor should the case then be allowed to pass from observation, but should be seen from time to time for another two months, in order to check any tendency to recurrence that may show itself. Partial occlusion usually permits of dilatation by means of rubber tubes. Should the lumen be too small, division of the tissues from the centre outwards will enable the surgeon to insert a tube. For collapse of the meatus or contraction at its orifice small dilators can be obtained at the instrument-makers, and are to be constantly worn. Most congenital occlusions are osseous, and inoperable.

Keratosis Obturans, or the Formation of Epithelial Plugs in the External Meatus.—This is a condition which occurs more frequently after middle age, and is due to an excessive casting off of epithelium within the deeper parts of the meatus and to its retention within it. If the disease has existed for a considerable time, the meatus is much distended in its innermost extremity, and the plug firmly adherent, or so tightly fixed that the line of demarcation between the dead and living epithelium is not clearly visible, and irritation is thus set up. This irritation increases the injurious effect of the pressure exercised by the plug, which is in its outer part formed of cerumen.

The chief symptom is that of deafness, accompanied occasionally by neuralgia of various parts of the head and considerable mental disturbance, especially in neurotic subjects, in whom a condition allied to melancholia sometimes develops.

TREATMENT.—First of all, an attempt is made to remove the mass by means of the syringe; but should this fail, as it frequently does, an endeavour may be made to separate the edge of the mass from the meatal wall by means of a probe, and then direct the stream of water from the syringe into the cleft thus formed, and so by means of *vis a tergo* expel the débris. Care must be exercised even by practitioners well skilled in the use of aural instruments in any attempt made to extract the mass by means of forceps or other instruments, more especially in elderly people, since pain and even rupture of the membrana tympani, which is at times attached to, and is always much weakened by the pressure of, the plug, may be caused. It is better to proceed more slowly, and to attempt to soften the mass by means of one of the guttæ or pastes (Appendix) containing salicylic acid. These are instilled into the ear at night, and every second or third day it will be possible to remove with the syringe some portion until the whole meatus is clear.

As subsequent treatment frictions of the meatus with oxide of mercury ointment, as will be described under the treatment of ceruminous impaction, may be adopted ; the meatus should be inspected every six months, especially where there is much dilation of the canal.

DISEASES OF THE CERUMINOUS GLANDS

Diminished Secretion.—When the secretion from the ceruminous glands is much diminished or entirely absent, the external meatus becomes very dry, and scales of cast-off epithelium are found within its lumen, which generally appears wider than normal on account of a certain amount of atrophy having taken place in its lining membrane.

These patients complain generally of a large amount of irritation in the external meatus, and at the same time not infrequently of subjective noises within the ear, in which case the deficiency of secretion will be secondary to, and part of, a chronic disease of the middle ear.

TREATMENT.—The dry, scaly condition of the external meatus is best treated by gentle frictions with a little cotton-wool twisted round a wooden or vulcanite probe, and lubricated with dilute ammoniated mercury ointment.

Excess of Secretion.—Excessive secretion of cerumen is due to a diseased condition of the ceruminous glands, and is closely allied in character to a seborrhœa. The nature of the cerumen is altered and its quantity markedly increased. It contains less moisture, and tends to accumulate within the meatus. Both ears are usually affected, but one is, as a rule, more blocked than the other. When this accumulation of wax occurs in children, adenoid vegetations are usually present in the naso-pharynx ; when present in adults, it is generally accompanied by some form of nasal stenosis and chronic naso-pharyngitis. Such facts lead to the belief that the increased activity of the glands is either due to an extension of inflammation from the naso-pharynx viâ the Eustachian tube and middle ear to the external meatus, or to a reflex irritation caused by nasal or post-nasal irritation. The ceruminous secretion is mixed with dust, epithelium, and hairs ; it gradually loses moisture, and thus becomes darker in colour and firm or hard in character.

Symptoms.—The constant symptoms of impacted cerumen are deafness, with or without subjective noises, and autophonia, whilst neuralgic pains over the side of the head may be induced ; irritation of a branch of the pneumogastric supplied to the skin of the meatus may cause a troublesome cough. The deafness is usually sudden and complete, and can frequently be traced to the entrance of a small amount of water into the external meatus, thence between the ceruminous plug and the meatal wall ; the deafness is due to the water stopping up this crevice, through which the sound-waves find their way, and later by causing the ceruminous plug to swell by imbibition, thus completely occluding the meatus.

Treatment.—The treatment consists primarily in removing the impacted cerumen, and secondarily in attempting to prevent its recurrence.

To remove the impaction recourse is had to the syringe, and it must be borne in mind that so long as the stream of water is directed along the posterior or superior walls of the canal, the amount of force used may, and should be considerable. Under no circumstances whatever must the stream of water be directed against the plug itself, for this would only drive it further into the meatus, or, should it have been removed, the stream of water would thus strike fully on the membrane, and considerable damage may be done. The temperature of the water should be at about 96° to 100° Fahr.

It frequently happens either that it is impossible to remove the plug at the first syringing or that its deeper portions cannot be evacuated. It then becomes necessary to adopt some means to soften the wax. One of the guttæ given in the Appendix (21, 22) may be prescribed, and a teaspoonful of the warmed lotion instilled into the ear shortly before retiring to rest, the patient being directed to sleep lying on the opposite side, having lightly packed the affected ear with cotton-wool. These drops should be repeated on two or three successive evenings, when the mass will be softened, and is readily disintegrated and removed by the syringe. No instruments are to be employed in removing these plugs unless the surgeon has had much experience in their use, as it is very easy for unskilled hands to cause irreparable damage by injuring the membrana tympani and the contents of the tympanum.

After the removal of all the cerumen the meatus should be carefully dried, and, if possible, no further investigation of the patient for deafness carried out until the effects of the syringing have passed off as all the tissues will be somewhat engorged with blood, and the curvature of the membrane has often been affected by the pressure of the plug.

The treatment towards prevention of recurrence of the trouble is based on the assumption that this condition is due to a diseased condition of the glands, and so the remedies must be directed towards restoring them to a healthy condition. The following method will give very good results :

The patient must be supplied with a small wooden or vulcanite probe, and directed to wrap round one end of this a layer of cotton-wool, being careful that the wool projects well beyond the probe. He should then take on his forefinger a small amount of yellow oxide of mercury ointment, 8 grains to the ounce of vaseline, and gently smear this on the mop, taking care that there is no excess of ointment upon it. With a mop so prepared, gentle friction is applied to the external meatus over its outer ¾ inch once or twice weekly. Too much stress cannot be laid on the importance of parsimonious use of the medicament, otherwise patients may completely fill their ears with ointment.

NEW GROWTHS

Papillomata are occasionally found at the entrance of the canal, and should be removed with a scalpel, the base being cauterized.

Malignant Disease commencing in the external meatus is relatively rare. When epitheliomata occurs it is usually accompanied by great pain, not limited to the part involved, but radiating over a large portion of the head and neck. An early symptom of this growth of the external meatus is fixation of the auricle. There is a thin offensive sanious discharge; deafness is not a necessary result, unless the growth fungates and occludes the meatus. On examination there is seen a ragged ulcer, with piled up and thickened edges, which bleed readily when touched with a probe. The glands in the upper part of the neck are soon involved, and it could only be in very early cases that the surgeon would be justified in attempting to extirpate the growth. If it should be

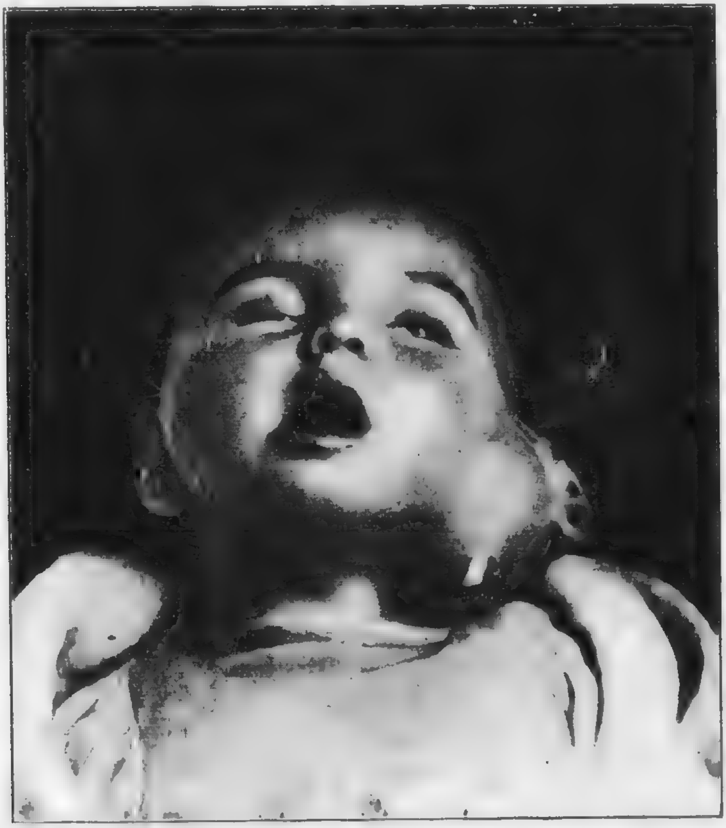


FIG. 39.—SARCOMA OF TEMPORAL BONE.

attempted, the operator must be prepared to carry out a deep, difficult dissection of the temporal bone.

Sarcomata and adeno-sarcomata may arise in this situation, and since they both tend to recur, they are to be freely removed if seen early.

FOREIGN BODIES IN THE EXTERNAL MEATUS

These are usually met with in children, or, in the case of adults, they have been inserted into the ear in childhood and their presence forgotten ; they are then usually inanimate. Occasionally an adult will ' pick ' his ears with a pin, which slips out of his fingers and drops into the deeper parts of the meatus. With these exceptions, foreign bodies in adults are usually of organized structure, such as polypi and necrosed bone, which are properly considered under the complications of suppurative otitis media. When a patient is brought with the statement that a foreign body is in the ear, it is a truism, but necessary to say, that, as far as possible, the practitioner should make certain that the foreign body is present before attempting its removal. He must remember that the extreme inner part of the floor of the meatus, as well as the lowest part of the drum, are frequently invisible, on account of the natural depression in the floor of the meatus at its inner part. Hence, if the sensation of the foreign body exists, no harm can be done in carefully syringing out the meatus.

Before proceeding, however, to the question of instrumental treatment, it is well to remember that even syringing for the removal of certain foreign bodies should not be attempted unless the surgeon is ready and able to take other measures. Vegetable seeds, if not removable by syringing, imbibe water and increase in size, often with disastrous consequences if operative measures are not quickly taken.

Foreign bodies in the external auditory meatus may be removed either by syringing or by the use of instruments, such as hooks and forceps. In a certain number of cases where neither of these methods avail, and where on account of swelling of the canal a severer complication threatens, it may be necessary to extract them by operative means.

Whichever method is adopted, the following precautions should be observed: (1) As the patients are usually children, with whom, unless exceptionally tractable, it is impossible to avoid damage to the important structures the surgeon must have the help of a general anæsthetic. (2) It is essential that good light is available, and all manipulations are carried out with its aid. If the foreign body is one which presents a surface easily grasped by forceps or a hook, or if it is possible to pass a hook or fine bent probe beyond it, then nothing more requires to be done. If the substance is smooth and the surgeon cannot pass an instrument beyond it, syringing will in most cases prove more efficacious. A small crevice usually exists between the foreign body and the meatus. This should be the side of the meatus along which the stream of water is driven, and particular care must be taken that, as far as possible, the object itself does not receive the full force of the stream of water.

Other methods of removing the foreign body, as by means of suction, may be considered. One of the most useful is by means of a fine indiarubber tube drawn over the nozzle of a large rubber syringe or Politzer's bag, which is exhausted, and the moistened end of the tube pushed gently but firmly against the foreign body, whilst the bag is allowed to expand and sufficient suction is sometimes obtained to withdraw the offending object. A fine piece of thread may be sometimes attached by means of glue or a quickly drying cement to the foreign body, and it may be withdrawn when the adhesive material has had time to set. A thin wire loop may occasionally be passed beyond and around the object. It may be advisable, when the foreign body is one which will swell by the imbibition of water, to syringe with oil. But whichever operation is resolved upon, it should always be borne in mind that unless the object has been introduced into an ear already the seat of suppuration, it may remain for a long time without causing any disturbance.

If an insect find its way into the external meatus it can always be destroyed by chloroform vapour, and may then easily be syringed out. Filling the meatus with oil brings the intruder within reach of easy removal.

When from one cause or another the foreign body has set up such an inflammatory disturbance that the meatus is completely occluded, and it is impossible to remove it in any one or other of the above ways, the ear should be reflected forwards by means of an incision close behind the auricle; the cartilaginous meatus is gently separated from the bony posterior wall, and then divided longitudinally sufficiently far back to enable the surgeon to lever out the object by means of a fine instrument passed beyond it. If this step should prove necessary the post-aural incision is to be carefully closed, and the external meatus thoroughly washed out and plugged with gauze under strictly antiseptic precautions. If there is no discharge a plug may remain *in situ* from ten to fourteen days, in order to thoroughly re-establish the patency of the canal.

RUPTURE OF THE MEMBRANA TYMPANI

This lesion has already been alluded to on p. 23, as far as its causation is concerned. It is only necessary to add here that when the membrane is ruptured as the effect of loud explosions, it will be found that in every case the membrana tympani is parallel to the external surface of the skull, that it does not appear to lie obliquely, and that the meatus is wide and straight, these conditions allowing the force of the explosion to impinge directly on the membrane.

SYMPTOMS.—Deafness, tinnitus, giddiness, slight discharge of blood, in many cases followed by purulent discharge. On examination a rupture will be found in the drum, usually in the lower segment when it is the effect of a blow or explosion, and a vertical tear when the base of the skull is fractured.

TREATMENT.—The external meatus and drum are to be carefully cleansed with an antiseptic solution—preferably 1 in 5,000 spirituous biniodide of mercury solution. A little iodoform should then be blown in, and the external meatus lightly packed with sterilized gauze.

An alternative treatment is to pass a small piece of glazed paper, moistened with an antiseptic or collodion. over the perforation. The paper adheres, and the membranes usually heal in a few days. The same light antiseptic gauze packing is employed as when no paper is used. If suppuration has occurred. the treatment suggested for that condition is to be employed

CHAPTER VII

EUSTACHIAN TUBE OBSTRUCTION

Obstruction of the Eustachian tube, of an acute or chronic nature, without material involvement of the middle ear, is a by no means infrequent cause of deafness. In both varieties the origin of the impaired patency of the tube is either occlusion at the orifice, more or less complete, from adenoid vegetations in the naso-pharynx, or from inflammatory swelling of its lining membrane, consequent upon an extension of inflammation from one structure or another in the naso-pharynx. In the acute cases the mucous membrane and submucosa of the tube are infiltrated with small cells and serum. In the chronic cases the small-celled infiltration has become organized, and a fibrous stricture remains. When the obstruction is intratubal, the site of contraction is rarely at the orifice, even in the acute cases, but is usually found at the outer extremity of the cartilaginous tube, at its junction with the osseous portion.

Acute Eustachian Obstruction.—The symptoms are distinctive. After a slight cold the patient notices sudden deafness, which is usually unilateral. He may complain of a feeling also of numbness with fulness in the affected ear, and when the hearing returns its restoration is preceded by a pop in the ear.

Objective Signs.—When the tympanic membrane is examined, the cone of light is usually found slightly higher than normal, and incomplete at its outer extremity. The handle of the malleus will be slightly injected, and the lining membrane of the inner wall of the tympanic cavity is commonly seen through the drum as a dull red reflex. The tympanitic condition, in fact, is one which, had it been slightly more pronounced, would have caused serous effusion into the tympanum. This form of obstruction is apt to recur at intervals, and then, like recurrent serous catarrh, tends to produce an adhesive otitis media, or to obliterate more or less completely the Eustachian tube, merging into a chronic condition. The patient is often markedly deaf, with tinnitus and will have a slight + or not unfrequently a − bone-conduction with a negative Rinne. If the bone-conduction is diminished, it will be restored after inflation.

TREATMENT.—As in most acute inflammatory conditions, a brisk mercurial purge is valuable; a sedative vapour, such as that from the compound tincture of benzoin, is also very helpful, the patient inhaling and exhaling the vapour through the nose. This inhalation should be repeated at intervals of four hours during the day, and the patient is better confined to the house. At the expiration of a few days, when the patency of the Eustachian tube is usually re-established, inflation of the middle ear should be employed bi-weekly for a few weeks, even though the hearing is entirely restored; for by this means subsequent attacks will cause less injury to the intratympanic structures, as the tendon of the tensor tympani will thus have been prevented from undergoing contraction. If the patency of the Eustachian tube is not restored, an Eustachian bougie should be employed a few times. At the same time a very careful examination of the nose and naso-pharynx should be made, and as far as possible a prophylactic treatment adopted—*i.e.*, one which aims primarily at obtaining a free air-way in the inferior meatus.

The presence of adenoid vegetations in the naso-pharynx, if the growth interferes mechanically with the normal opening of the tube, will cause symptoms of obstruction, usually of a chronic character; but if the growth is rapid, comparatively sudden deafness will be produced.

Chronic Obstruction.—Chronic obstruction of the Eustachian tube is a very frequent forerunner and concomitant of the adhesive form of chronic middle-ear disease, and its presence materially contributes to the extreme retraction of the drum seen in some of these cases. In fact, an extreme retraction of the membrane is the chief sign of an old-standing contraction of the Eustachian tube ; in a certain proportion of cases of chronic middle-ear disease, the stricture of the tube forms the most important part of the disease, and when the patency of the canal is restored a great improvement in hearing is almost immediately noticed. Tinnitus is again a common symptom.

DIAGNOSIS.—In all forms of tubal obstruction a diagnosis is made partly from the appearance of the drum, but principally from the sound obtained by using the Eustachian catheter ; when the tube is obstructed the sound is small, distant, and sibilant ; whilst, with a free tube, as has been mentioned, the sound is full and near.

At times the cartilaginous end of the tube is chronically enlarged. When both are affected they may almost meet in the middle line. Polypi have been seen in the entrance of the tube.

TREATMENT.—The treatment which yields the most satisfactory result is the regular use of the Eustachian bougie. These are made of gum elastic or celluloid, and may be passed, two or three times a week, until the tube remains free. (The use of the bougie is described on p. 74.) The bougie should be left *in situ* for from two to five minutes, and it is always advisable to pass the largest size possible. Besides the use of flexible bougies the practitioner may employ electrolysis. The external meatus is filled with water, and the negative pole placed within the meatus, while the positive pole is connected with a fine vulcanite bougie tipped with metal. The current must be turned on very gradually, and not kept on for more than three minutes at a time ; care must be exercised in breaking the flow of the current, since rapidly disconnecting the poles is apt to cause a severe vertigo. The most suitable strength of the current is about 5 milliampères. As an adjunct to this mode of treatment the naso-pharynx should be painted after each sitting with Mandl's weak solution (Appendix 39).

Other diseases of the Eustachian tube which deserve a passing mention are ulceration of the tube or Rosenmüller's fossa. Either syphilitic or tubercular, they require the usual and general treatment adopted for these conditions in other parts of the body.

CHAPTER VIII

ACUTE DISEASES OF THE MIDDLE EAR

Acute Inflammation of the Middle Ear—Acute Otitis Media.

Acute inflammation of the tympanic cavity is the result of an infection which may reach it either by way of the Eustachian tube, the blood-stream, or the lymphatics of the part.

The part played by an inflammation of the naso-pharyngeal mucosa in the production of acute otitis media is a very large one. In fact, it is doubtful whether, apart from tubercle, any cases of acute middle-ear infection occur in which an inflamed state of the naso-pharyngeal mucosa is not already existing.

The principal cause is undoubtedly the direct extension of inflammation of the Eustachian tube from the naso-pharynx; sometimes this is the sole cause, at others the primary.

Otitis media is a frequent complication of the various exanthemata and of acute infectious disorders. Foremost amongst these are scarlet fever, measles, diphtheria, whooping-cough, and typhoid fever. It also occurs secondarily to any naso-pharyngeal inflammation, more especially that accompanying the general symptoms of influenza, and it is at the same time one of the most serious complications of bronchitis and capillary bronchitis in children. Patients with obstructive nasal disease or those suffering from hypertrophic disease of the naso-pharyngeal tonsil are especially liable to acute inflammation of the middle ear.

No more fruitful cause of acute middle-ear infection exists than the forcible projection of septic material into the middle ear, which is so frequently the result of too determined effort at clearing the nose by blowing when the patient is suffering from acute nasal catarrh. Nor must the occasional ill-effect of the nasal douche be forgotten, for if too great force be used infective matter may be forced by the stream of fluid up the Eustachian tube into the middle ear.

PATHOLOGY.—The inflammatory changes which have their starting-point in the naso-pharynx cause engorgement of the lining membrane both of the Eustachian tube and of the cavum tympani; the whole of this swollen mucosa is infiltrated with leucocytes. The tympanic cavity then becomes more or less filled with muco-serous exudation, in which is found a variable number of micro-organisms mixed with leucocytes liberated from the lining membrane of the tympanum, the attic, and the antrum. The membrana tympani itself is involved in the spread of the general inflammation, and a further extension of inflammation not infrequently proceeds along the external meatus, by which its soft tissues are swollen, with partial occlusion of its lumen; serous or sanious bullæ are sometimes formed on the meatal walls, and are followed, after the absorption or removal of their contents, by desquamation. In fact, in this disease it is not an infrequent experience to obtain an almost complete epithelial cast of the external meatus.

SYMPTOMS.—Pain is the prominent symptom, and in character it may be paroxysmal or continuous. Patients refer it usually to the ear, but frequently it radiates over the affected side of the head. The pain is increased by pressure on the tragus, and often by movement of the jaw. It is worse at night, and accompanied by a relatively high temperature—from 101° to 103° F. A slight rigor is not infrequently experienced in the early stages of muco-purulent cases. A sense of fulness in the ear, autophonia, and deafness are as constant as pain. In children there may be delirium and convulsions; in very young patients it will often be noticed that the infant is continually putting the hand to the affected ear, or that he prefers to lie on the other side, and always screams when the ear is touched by the mother or nurse.

Incessant crying in children, not obviously abdominal in origin, should always direct the practitioner's attention to the sufferer's ears. As has already been mentioned, the skin of the external meatus is sometimes involved, and that even in the early stages of the disease. If so, its innermost part, if visible, is red and swollen, and bullæ (Plate I., Fig. 12), containing either clear or sanious fluid, are occasionally noticed in this situation. The swelling of the meatus may be so great as to render impossible all inspection of the membrana tympani. It is in the membrana tympani itself, however, that the most characteristic changes are noticed. In the earliest stages of inflammation there is seen on the handle of the malleus a dilatation of its vessels, and on careful inspection a leash of vessels will be observed running from the posterior superior part of the periphery down to the handle of the malleus, near the short process (Plate I.). No further extension of the inflammatory process may occur, and the attack will then end in resolution. In the next stage the handle of the malleus becomes uniformly red, and small radiating vessels may be noted on the drum itself, the short process not altering in colour (Plate I.). As the inflammatory process develops the handle of the malleus loses its sharply-defined border, and resembles in shape the finger of a glove, and in colour changes to a bright red hue. It is at this stage that the epithelial covering of the short process becomes involved in the general inflammatory state, whilst the membrane as a whole gradually becomes pink, and the vessels radiating from the handle of the malleus more numerous and more dilated. The cone of light disappears, and the membrane becomes lustreless. From pink the membrane changes to red, and the posterior half bulges outwards, hiding the anterior portion. At this stage it is impossible to distinguish the outline of the malleus or the edge of the tympanic membrane, for the adjacent parts of the meatus are probably also inflamed. Should the disease tend towards resolution, all the above-mentioned changes will take place in inverse order, with the exception that, as the membrane recovers its normal colour and curvature, striæ radiating from the malleus will become visible on its surface

(Plate I.. Fig. 3). These are the result of the distension of the tympanic membrane, and are due to relaxation of its fibres when the distending force is removed ; they disappear in the course of a few days, and have no significance. whilst the membrane gradually becomes again lustrous. and the cone of light reappears. Should suppuration occur, the drum will be perforated. and the pus will show itself. if in sufficient quantity, in the external meatus. Discharge from the canal in these cases may be almost clear or sanious at its commencement. but in either event it will gradually become purulent, and is very often ropy in character. This mucoid discharge is considered to be exuded from the Eustachian tube. When the inflammation is severe and secondary to one of the exanthemata. the perforation may be of great extent and spread rapidly. The major part of the drum in such an event may be destroyed, and partial necrosis of the ossicles is a frequent complication The whole membrane is sometimes destroyed in the course of a few days. When, however. the inflammatory products become localized and confined either to the attic or posterior superior quadrant. the practitioner will perceive on examination of the ear that instead of the bright red uniform swelling as above described, there is a bright red pouch resembling a polypus hanging either over the malleus or behind it. In the former instance it is a bulging of Shrapnell's membrane ; in the latter, a bulging of the posterior superior quadrant of the membrane (Plate I., Fig. 4). One may be able to detect a small granulation near the apex of the swelling. This spot is the site of the perforation of the pouch. and from its resemblance to a polypus a mistaken diagnosis may be made. When a perforation takes place in the anterior segment of the membrane it is more difficult to detect than one situated in the posterior portion.

Genuine polypus formation. even in acute cases. however. occurs. the polypus springing from an ulcer in the mucosa of the inner tympanic wall at the same level as the perforation.

One condition which is occasionally mistaken for acute otitis media is an acute inflammation of a lymphatic gland lying just beneath the sterno-mastoid muscle. This causes a slight inflammation of the sheath of the muscle itself, which produces pressure on the tip of the mastoid, giving rise to pain. It, however, can be easily distinguished from acute otitis media by the fact that the drum membrane is normal in character, and usually by noticing that there is some septic condition in the mouth or pharynx, which is the primary cause of the glandular enlargement.

TREATMENT.—The objects which the practitioner must have in view in the treatment of the early stages of acute inflammation of the middle ear are, firstly, to relieve pain and to avoid suppuration and consequent perforation ; secondly, in the event of perforation having occurred, to check the tendency to involvement of the mastoid antrum and mastoid cells ; and, finally, to stop the discharge and heal the perforation. The treatment must necessarily vary with the general condition of the sufferer ; also whether he is affected with a severe constitutional disease, such as scarlet fever, or if the local trouble itself is the chief or only complaint ; and it may not be out of place to impress on the reader the necessity of a careful, methodical, and systematic examination of the ear in every case of acute specific fever, with the view of detecting inflammatory changes early, and by suitable measures aborting them. If the patient suffers from an acute infectious disease and the inflammatory condition of the ear is discovered quickly, three or four leeches should be applied over the mastoid, and hot boracic fomentations and aural irrigations employed, while the nasal cavities are sprayed with a mild antiseptic solution, either 25 per cent. of Listerine, or a weak boracic solution. If, on the other hand, the inflamed state of the ear is the only disorder to be considered, a sharp mercurial purge is an advisable initiatory treatment, to be at once followed by a saline aperient. In adults 1 gram of opium may be advantageously added to the mercurial. At the same time three to six leeches are applied over the mastoid process, close to the attachment of the pinna, and bleeding further encouraged by hot fomentations of boric acid, the external meatus being syringed with the same solution. Instead of leeches, which are sometimes difficult to procure, the artificial leech may be employed. If the external meatus be obviously involved by the inflammatory process, one leech may be placed in front of the tragus; in such cases the external meatus should previously be lightly plugged with cotton-wool to protect it in case the leech moves. To relieve the pain, a piece of cotton-wool soaked in Battey's solution of opium, or an aural ovoid (Appendix) containing opium may be inserted into the external meatus. Chloroform vapour is a very valuable local anodyne. If these measures do not rapidly relieve the pain, no time should be lost before proceeding to incision of the membrana tympani after a careful and thorough cleansing of the external meatus. Incision may be practised for the relief of pain, even when no bulging of the membrane is observed. If any bulging of the membrana tympani is detected it becomes imperative. Incision in these cases must be free, and made vertically behind the handle of the malleus, extending from the bottom of the membrane to the top, and may be carried ½ inch along the external meatus at the junction of the posterior and superior walls; a small incision being often worse than useless. Another incision advocated is transverse in direction, a semilunar one with the convexity downwards; this is not so uniformly desirable as the former, except in cases where the inflammatory trouble is restricted to the lower part of the cavum tympani. This slight surgical measure is frequently advisable also where a perforation is small and tends to become obstructed, thus preventing the free exit of the exudation. It may be noted that the propriety of this procedure has been questioned in acute inflammatory disorders when a complication of the exanthemata.

Both after incision, as well as after pathological perforation of the membrana tympani has taken place, the ear must be carefully cleansed with some antiseptic solution—for example, either ¼ per cent. lysol or that of perchloride of mercury (1 in 3,000). Peroxide of hydrogen is useful in these cases, as it decomposes the discharge and penetrates more readily and deeply than the purely antiseptic preparations. After drying the meatus, some powdered iodoform is blown into the ear, and the meatus plugged loosely from the bottom with a thin strip of antiseptic gauze, care being taken to pack the deeper parts equally with the more superficial. This dressing is changed as often as the external portion of the plug becomes moist with the discharge, the ear being irrigated in the same manner at each subsequent dressing. Be careful that the gauze touch the drum at the site of incision or perforation, so as to cause it to act as a syphon.

An alternative form of treatment, or one which some aurists recommend in combination with the foregoing, consists in blowing into the middle ear through the Eustachian tube, by means of the catheter, a few drops of ½ per cent. izal oil in parolein, or the middle ear may be irrigated by the same route with sterilized normal saline solution. This may be done at the commencement of the treatment if the patient is able to tolerate it, and is much to be advocated if the medical attendant has the necessary skill.

In cases where the inflammation tends to extend rather than to yield to treatment, even if no indication of mastoid involvement occurs, opening the mastoid antrum should be considered; but if obvious involvement of the antrum, or any other of the complications noted, are manifested, they are to be dealt with as laid down.

General Treatment.—Tonics and attention to diet and general hygiene, as well as the use of a cleansing spray to the nose, are useful. But above all, sending the patient to a healthy locality, where good air and sunshine are to be found, will often complete a cure; but this must not be entertained where there is any suspicion of mastoid involvement.

Acute Suppuration of the Tympanic Attic.

Inflammation may be limited entirely to the attic, and not involve the cavum tympani proper. In these cases the inflammatory process commences in the attic, and is sufficiently acute and accompanied by such an amount of infiltration and swelling of its lining membrane as to close the orifices left between the neck of the malleus, the long process of the incus, and the constricted walls at the base of the attic. The causes of acute suppuration in this region are catarrhal conditions of the naso-pharynx, extending up to and involving the middle ear and attic, but in which the drainage of the main cavity or cavum tympani is not interfered with by closure of the Eustachian tube. Hence the genuine middle ear trouble is very evanescent and produces no symptoms. It is more common in adults than in children, and therefore is a relatively rare sequel of the exanthemata.

SYMPTOMS.—Deafness, a feeling of weight in the ear, and pain, followed by discharge. Deafness, in acute suppuration in the attic, is not so complete as that which occurs in inflammatory disease of the cavum tympani proper, even in the severest forms of attic inflammation, and in the milder attacks there will be only slight noticeable deafness ; but in all cases there will be a sense of fulness and weight in the ear, together with more or less pain, and on examination of the patient a small reddish tumour will be noticed situated in the upper part of the drum, and usually obscuring the short process of the malleus, from a tendency which it has to become polypoid and dependent. This little tumour is smooth and of a bright pink colour, less intense than the colour of an aural polypus in this situation, and after discharge has commenced a granulation may frequently be noticed near the apex of the tumour, and by means of Siegle's speculum a small amount of pus may be caused to exude from the tip. In rare instances redness is confined to the roof of the meatus, and therefore the membrane of Shrapnell is seen without any bulging, but pain, deafness, and fever are present. The temperature of the patient is rarely raised, nor does he suffer from any severe discomfort.

TREATMENT.—After thoroughly cleansing the canal, Shrapnell's membrane, whether bulging or otherwise, is incised, or, if polypoid, it may be cut off with a snare ; the external meatus is subsequently irrigated and filled with aseptic packing. The gauze should be changed every day, and after the ear has been cleansed with an antiseptic solution, powdered iodoform or boric acid is insufflated. The ear may be inflated after the attic membrane has been incised, in order to drive out any residual pus, a procedure which may be repeated before each dressing. By this treatment, if carefully carried out, healing may in favourable instances be obtained within a fortnight.

Complications of Acute Otitis Media.

Facial palsy; adenitis; mastoiditis; mastoid abscess; isolated abscess in the mastoid; perforation of the upper or inner wall of the mastoid, with subsequent abscess within the cranium; perforation into and purulent collection in the digastric fossa, with its possible extensions, as along the Eustachian tube into the pharynx; acute labyrinthitis; acute pyolabyrinthitis; acute meningitis; acute intradural or cerebellar abscess; more rarely acute cerebral abscess, or pyæmia.

Facial Palsy.—Facial palsy is a symptom of no great significance in acute diseases of the middle ear, in which point it differs materially from chronic suppurative diseases of the middle ear. The paralysis is not of long duration if the aural disease is properly treated, and need not be looked upon as an indication for operation.

The nerve lesion is caused by an extension of the inflammation from the middle ear into the Fallopian canal, either on account of the thinness of its wall, or, as occurs in the majority of instances, in consequence of a small dehiscence in the osseous portion of the wall, usually situated just above the fenestra ovalis. When the inflammatory process has extended to the interior of the canal, both the periosteal lining of the canal and the neurilemma become infiltrated, and the nerve is thus compressed, with consequent paresis of the muscles supplied.

That variety of facial paralysis which sometimes occurs after exposure to a draught is due to an otitis media of a transient character. The treatment of this complication, so far as the facial muscles are concerned, should be postponed until the inflammatory exudation within the Fallopian canal has subsided, when, if there is still any want of action on the part of the facial muscles, the faradic current is to be employed. If the paralysis, however, is of long standing from neglect of treatment, and the muscles exhibit the reaction of degeneration, voltaic interruptions of the constant current will at first be found more beneficial.

Adenitis.—The lymphatic glands, sometimes involved secondarily to an acute suppuration in the middle ear, are the pre- and post-auricular glands and those situated beneath and on each side of the sterno-mastoid muscle in its upper third. It is occasionally necessary to make a diagnosis from an inflamed substerno-mastoid gland from mastoiditis. The chief point to note is that in adenitis the mastoid is only tender at the site of the tendinous insertion of the muscle. Should an inflammatory swelling of any of these glands take place, a by no means uncommon event in young people, resolution will be obtained by the application of heat, and of a mixture of

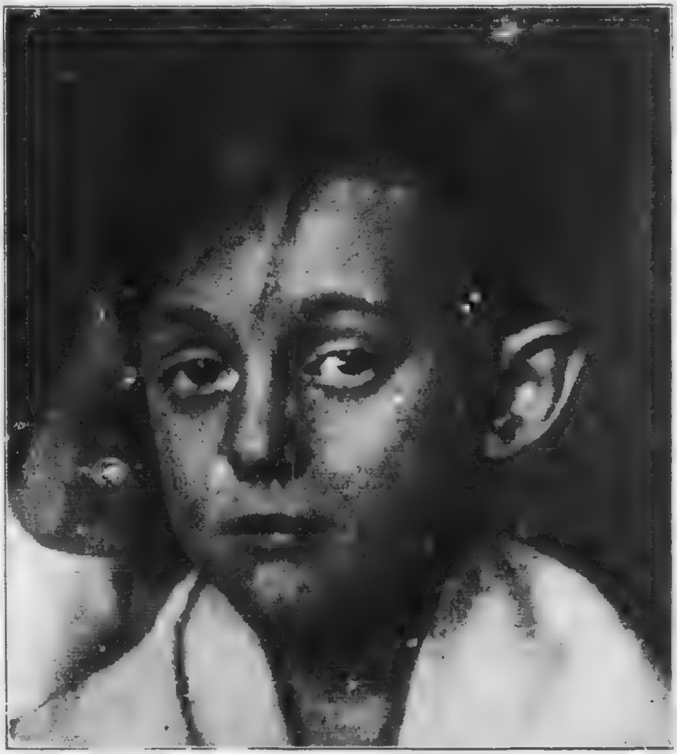


FIG. 40.—ACUTE MASTOIDITIS: PROJECTION OF EAR DOWNWARDS AND FORWARDS.

equal parts of extract of belladonna and glycerine painted locally; the absorbent action of this preparation is assisted in children and young adults by the administration of occasional small doses of hydrarg. c. creta.

Mastoiditis; Mastoid Abscess; Isolated Abscess in the Mastoid.—The anatomical structure of the process has a distinct bearing on the liability of the individual to this complication, the larger the antrum and the more cellular the bone the greater the probability of a purulent collection in the part. The earliest symptom of involvement of the mastoid is usually either that of pain on slight pressure at the upper and anterior part of the mastoid process just behind the ear, or of tenderness on deep pressure at some other part of the bone, usually its anterior and lower limits. With such a symptom it is probable that suppuration threatens—in the former situation in the mastoid antrum, in the latter in some other part of the bone. A more or less superficial tenderness over the whole mastoid is, on the contrary, rather an indication of a general periostitis. If suppuration takes place pain will then become pronounced on deep pressure, but the opposite side must be invariably tested to control the result obtained. Neuralgic pain is often felt on that side of the head. Fever usually returns if it had subsided, or a definite increase in the existing pyrexia takes place. The temperature often rises rapidly, to 103° or 105° F., and is accompanied, especially in children, by a slight rigor; in adults the temperature is at times not raised above the normal, or it may even be occasionally slightly subnormal, and no pain complained of except on direct and firm pressure. The discharge from the meatus often ceases entirely when suppuration occurs in the deeper parts, to reappear twelve to twenty-four hours later; at other times no alteration in the quantity will be noticed. Redness, swelling, and œdema, which latter may be very extensive and involve the temporal fossa, are present over the mastoid in the majority of instances, though they are observed less frequently as the patient's age advances. The softer and more porous the bone, the greater the rapidity with which this redness and swelling appear; if treatment be delayed pus collects beneath the periosteum. the ear projects from the side of the head. being pushed forwards and downwards in children, forwards in adults. and fluctuation may readily be detected ; the abscess may. if untreated. extend over the whole of the mastoid and upwards towards the temporal fossa. It is a fact. however, that with the external perforation of the bone. and the collection of pus beneath the periosteum. the danger of intracranial lesions is much lessened. As additional evidence one may find bulging of the posterio-superior meatal wall, and slight nystagmus.

Treatment.—Whether or not the membrana tympani has been perforated. especially in children. the application of three leeches over the mastoid. followed by hot boracic fomentations to continue the bleeding. will again and again cut short the progress of acute mastoiditis. though. if these have already been employed just previously to the mastoid involvement, their re-employment is not advisable. Some observers recommend the antiphlogistic properties of cold. applied by means of a coil of rubber tubing through which cold water is allowed to flow. In the majority of instances, however, it will be found that leeches and hot fomentations are a more certainly abortive mode of treatment. Hot boracic irrigation of the meatus is always beneficial. and often alleviates the patient's sufferings. If at the end of twenty-four hours there is no good evidence that the disease is being controlled, the practitioner cannot too strongly urge the necessity of immediate operation. and he must point out the danger there is in unnecessarily delaying the opening of the mastoid antrum.

If. however. the case has been allowed to go on untreated, or if. despite treatment. an abscess is present on the mastoid, it will in children be usually found that the pus has perforated the outer layer of the bone. In these cases the patient may be unable to sleep on account of the severe pain ; the temperature is increased. and there are marked signs of constitutional disturbance. If the abscess external to the bone is not opened it will follow the course of any other acute abscess. Sloughing with consequent perforation of the skin. will take place, with a free discharge of pus. and a sinus will be left leading down to the temporal bone and communicating with the mastoid antrum. In other cases the antral abscess will discharge itself into the external meatus by a perforation of its superor or posterior wall. In other instances, and usually in adults where the outer table is of considerable density, and where the mastoid process is formed entirely of cells, the pus may perforate the outer wall of the digastric fossa, and then, following the direction of the fascial planes, present itself in the pharynx, naso-pharynx, occipital region, or beneath the sterno-mastoid muscle—this variety is known by the name of 'Bezold's mastoiditis'—and occasionally at the same time pus may find its way into the sigmoid groove, and an acute extradural abscess be formed.

VACCINE THERAPY.—Allusion must be made to the employment of vaccines in the treatment of suppurative conditions in the middle ear external meatus, temporal bone, and meningeal inflammation of aural origin. It is rare that vaccines are to be justified when suppuration is present in the bone, but in mild subacute cases of middle-ear suppuration, and in all cases of meningeal infection, they should be employed.

Acute Labyrinthitis.—Occasionally, during the course of an acute otitis media, the patient will complain of vertigo. This will mean that the bony capsule of the posterior half of the labyrinth has become inflamed, and although, even if no operation is undertaken, it is extremely unlikely that the labyrinth will become the seat of purulent inflammation, yet it is more than probable that if this symptom is not made the indication for immediate operation, the inflammation may spread into the anterior half of the labyrinth, and the cochlea become involved as well. This will mean that on the recovery of the patient almost complete loss of hearing will follow; so that vertigo, occurring in a course of an acute otitis media, may be considered as a definite reason for immediate operation, despite any apparent tendency for the disease to subside. When pus obtains entry into the labyrinth, all the symptoms described on p. 259 will be present.

In the first instance an immediate opening of the mastoid may save the hearing. For the treatment of the latter, see p. 261.

Intracranial lesions will be discussed subsequently (*vide* p. 282 *et seq.*).

As sequelæ, adhesions within the cavity of the tympanum, fixation of the malleus, with a tendency to deafness at a subsequent period, and not infrequently otosclerosis may occur.

Acute Tuberculous Disease of the Middle Ear.

It is not to be wondered at that the middle ear, with its irregular cavities, minute vessels, and free lymphatic supply, should occasionally be the site of acute tuberculous inflammation. This variety of middle-ear disease is itself a comparatively rare complication, and but rarely found in patients already the subjects of pulmonary tuberculosis; it would therefore appear to be frequently a primary tuberculous lesion, the bacillus finding a lodgment in consequence of some local loss of the power to combat infection, either in the middle ear itself or in some part of the mastoid process. When the disease is secondary to a pulmonary lesion, it usually occurs late in the disease, and as such will rarely be seen by the aurist, and it then has a very serious significance.

SYMPTOMS.—The *Subjective Symptoms* consist of deafness, tinnitus, a sense of fulness in the ear, and discharge. The deafness is often sudden in onset, and found without any acute inflammatory state of the naso-pharyngeal mucous membrane. Pain is strangely absent in the majority of instances. When present, it is usually slight and transient in character, and may certainly be said never to approach in severity that usually experienced in simple inflammatory cases. The tinnitus presents no special features. The discharge is usually watery and scanty.

Objective Symptoms.—On examining the ear with the speculum, after cleansing the meatus, it may be possible to detect a perforation, usually situated in the anterior part of the drum, whilst the posterior segment is bulging, and presents either a dull, pale pink colour, with enlarged vessels ramifying across it, or a uniformly dull red hue. The membrane never presents that brilliant red colour seen in non-tuberculous inflammation of the mucous membrane. The swollen drum also exhibits a peculiarly sodden and thickened appearance, and if pressure is made upon it with a probe there is only slight yielding and but little pain produced. Frequently there is slight fever, but the peculiarities of the inflammation consist in the relative painlessness of the perforation and the pathognomonic appearance of the drum. Enlargement of the post-auricular lymphatic glands is occasionally found. If the mastoid cells or antrum form the site of the primary infection, a rapid and painless mastoiditis ensues, with the formation of subperiosteal abscess, characterized by the absence of the common acute symptoms, especially of pain. Tubercles are said to be visible in the tympanic membrane in certain cases as grey, pearly spots. The process will, in such instances, be more acute, and a more rapid destruction of the tympanic membrane will take place, with a correspondingly rapid involvement of the surrounding soft tissues and bone ; it will then be accompanied by severe constitutional disturbance. When the membrane is of a dull red colour, multiple perforations are often seen (*vide* Plate IV., Fig. 2). Facial paralysis is frequent.

TREATMENT.—In primary tuberculous disease of the middle ear the drum should be incised under a general anæsthetic through the whole vertical length of the most bulging portion ; after incision, the posterior segment of the cavity of the middle ear is to be carefully curetted with a small sharp scoop. It is well to preserve for microscopic examination all the tissues removed, since the presence of tubercle bacilli may be demonstrated in the débris, or the diagnosis may be verified by the inoculation of some of the material into a small rodent. The surgeon will notice that there is no immediate tendency to collapse of the membrane, a fact which demonstrates that the drum and the membrane lining the middle ear are very much swollen, and that the bulging of the drum is due more to cell-infiltration and cell-proliferation, with the formation of tubercles, than to the presence of fluid in the cavum tympani.

After curettage the cavity of the middle ear must be well flushed with a 40 per cent. solution of lactic acid through a Hartmann's cannula. This irrigation is repeated at least once daily by the surgeon, and the wound in the drum kept open by breaking down by means of a probe any adhesions which may form between its edges; the meatus is to be plugged with a strip of gauze after blowing in some powdered iodoform.

It is needless to say that this local treatment must be supplemented by a proper constitutional regimen, and it is always advisable to examine the naso-pharynx with a view of discovering whether or not there is any discharge of pus from the Eustachian tube, as the pharyngeal vault or the larynx may in this way become infected.

Should the disease not yield to the above line of treatment, or the symptoms be fulminating in character, or the infection be primarily of the antrum or mastoid cells, then a most careful and thorough radical mastoid operation ought to be performed without unnecessary delay, and every vestige of the mucous membrane of the middle ear and of its subsidiary cavities, together with every trace of inflamed and diseased bone, removed. (The general description of the radical operation will be found on p. 213.) Once the diagnosis is made, it is obligatory that the patient or his friends be made thoroughly acquainted with the serious nature of the disease, and that, trivial though it may appear to him, it is capable of infecting his whole system, and that, through the least negligence on his part, it may produce the most serious consequences. He must be enjoined to cleanse daily his naso-pharynx by means of nasal irrigation. For this purpose there is nothing pleasanter than a 25 per cent. solution of Listerine.

As sequelæ, ulceration in the naso-pharynx is found, though comparatively rarely; the muco-pus dropping down frequently infects the larynx, and also, by passing into the alimentary canal, causes general infection. Operative treatment to be effective must be prompt. The mastoid cells become infected from the middle ear, and a large and ragged cavity forms in the temporal bone, destroying it entirely and infecting the system generally.

Tubercular Disease of the Temporal Bone in Children.

This is by no means an uncommon condition, and though, fortunately, often unilateral, yet may be bilateral. The attack is generally very insidious, and is accompanied, but not usually ushered in, by a discharge from the ear, for the site of attack is most commonly the soft growing bone of the petrous and mastoid in children of tender years. The squamosa is extremely thin and is separated from the petrosal by the squamo-petrosal suture, and the mastoid process is not yet developed. Pain is rare—at all events, is not a prominent symptom. Post-aural swelling, soon followed by fluctuation, and, quite commonly, by facial palsy, is frequently the first thing that the parent notes. This is due, no doubt, largely to the fact that the sufferers are drawn from quite the poorest and worst nourished class of the community. Anæmia and cachexia are marked, and, of course, great, if not absolute, deafness, and probably facial palsy.

TREATMENT.—Local operation, and that of the most radical nature, is imperatively demanded; and it should be borne in mind that the procedure is one of surgical necessity, and not an operation undertaken for the usual reasons which demand a mastoid operation, for failure to eradicate the disease means death to the patient.

On cutting down through the ordinary post-aural incision, a sequestrum, embracing at times the complete temporal exclusive of the squamous portion or only part of the bone, will, in the majority of cases, be found. This must be abstracted, and if the anatomy of the adult bone is considered, this presents a serious danger; but, fortunately, in children the carotid canal is not yet formed, and the bulb of the jugular vein is not endangered. The only structure injured is the facial nerve, and that will probably be destroyed.

The whole cavity is now carefully and conscientiously curetted, and as far as possible reduced to one bounded only by fibrous tissue, which is well cleansed with 2 per cent. formalin or Lister's strong solution.

Acute Hæmorrhagic Otitis.

This variety of otitis media is, in the majority of instances, an accompaniment of or a sequel to influenza, though it does occur without known cause, and is occasionally a complication of renal disease; it may also accompany a mild attack of otitis in patients afflicted with the hæmorrhagic diathesis.

SYMPTOMS.—The symptoms are deafness, pain, and discharge of blood from the external meatus.

Objective Symptoms.—The membrane is not usually bulging, nor is the handle of the malleus reddened and broadened, but the membrane itself shows in the early stages a dull red reflex, without material interference with the cone of light. This dull red reflex is due to an engorgement of the mucous membrane covering the inner wall of the tympanum, and resembles in hue the dusky redness of the pharyngitis of influenza. When hæmorrhage has taken place, usually in influenzal cases about the fifth day, the drum exhibits, at the lower and posterior parts, one or more small hæmorrhages; sometimes even a small adherent clot of blood may be seen in the same situation (Plate I., Figs. 7 and 8). The duration of the complaint is about a fortnight, though, if due to abnormal conditions of the blood or general systemic disease, relapses occur.

TREATMENT.—If the case be seen before hæmorrhage has occurred, and the condition recognized, constitutional treatment may abort or control an attack. Lactate or phosphate of calcium, in 10 to 15 grain doses, seem to be indicated, or small and frequent doses of one of the preparations of the suprarenal capsule. After a hæmorrhage has occurred the ear should be lightly plugged with a strip of antiseptic gauze; if there is much pain, either the gauze may be moistened with a few minims of Battey's solution of opium or an aural ovoid containing opium inserted. It is not advisable to perform paracentesis of the drum for the relief of pain in these cases, as the hæmorrhage which ensues may cause considerable annoyance.

Serous Catarrh of the Middle Ear.

Causation.—Serous catarrh of the middle ear is invariably secondary to an inflamed condition of the naso-pharyngeal mucosa, however slight or transitory this may have been. Careful cross-examination of the patient will always elicit the fact that, shortly before the aural trouble was noticed, there had been symptoms of nasal or naso-pharyngeal trouble. The inflammatory process travels up the Eustachian tube by continuity of tissue, causing obstruction of its lumen, which results in an excessive secretion, serous or mucoid, in the middle ear. The outlet being occluded, the fluid rapidly accumulates, and after subsidence of the swelling of the mucous membrane of the tube, the secretion remains in that portion of the cavum tympani which is situated at a lower level than the tympanic orifice of the Eustachian tube. It is rare in adults to find both ears affected at the same time, but subsequent attacks are common.

Symptoms.—The chief subjective symptoms are a more or less pronounced degree of deafness, a sense of fulness in the ear, tinnitus, and occasionally patients express themselves as feeling as if 'something rattled in their heads' when they moved about. Not uncommonly there is a kind of double hearing complained of, the tone and pitch of a note being altered on the side affected, while autophonia is a very constant symptom.

Objective Signs.—The membrana tympani is not visibly altered in curvature, but the cone of light is higher—that is to say, slightly more horizontal—not often divided, but showing that there is an alteration in the general curvature of the drum, though not sufficient to be appreciated by the eye. The most valuable sign, however, is the presence of a dark curved line across the drum, with its concavity upwards and its higher extremity posterior, simulating the appearance of a hair lying across the tympanic membrane. This line of demarcation indicates the upper limit of the fluid. The cause of this line being at a lower level in front is due to its extending to the lower margin of the tympanic orifice of the Eustachian tube, the higher level behind being due to capillary attraction. The line is caused by absorption and refraction of the light rays as they pass through the upper surface of the fluid. The part of the membrane below the dark line may appear quite normal, signifying that the fluid is composed wholly of clear serum; or this crescentic portion may be straw-coloured, due to the darker colour of the fluid; or lastly, it may have a yellowish-white tint, caused by the mixture of a relatively large amount of mucus. Occasionally the whole membrane is divided into dark circlets with white centres. These are small bubbles of air and fluid. A similar appearance may be obtained after inflation if the tympanic cavity contains much fluid, as it is then made frothy. In rarer instances, especially in childhood, the whole or a portion of the membrane may be distended, with or without slight inflammatory blush in the region of the handle of the malleus in children. In these cases there will be no line of demarcation present, and it is often noticed that the bulging drum is white and rather dull, suggesting, rather, that the bulging is due to air and not to fluid.

TREATMENT.—The principles which should be followed in the treatment of this disease are, firstly, to obtain a free passage of fluid from the ear into the naso-pharynx; and, if this fail, either to promote absorption of the fluid in the ear, or to expel it. Preliminary treatment consists in the administration of a mercurial purge, followed by a saline draught. Inflation of the middle ear may be safely attempted in order to drive the fluid from the cavum tympani down the Eustachian tube into the naso-pharynx, but it is advisable, first, to wash or spray out the nose and naso-pharynx with a mild antiseptic, as 1 in 10 Listerine.

The nasal detergent spray is helpful (Appendices 1 and 2), and benzoic vapour should be inhaled and exhaled through the nose; chloride of ammonium vapour may be substituted if the patient is unable to remain at home, as no patient ought to be allowed to go out of doors for at least one hour after the use of a warm inhalation

The surgical or immediate treatment consists in an incision of the drum, and the subsequent evacuation of the fluid from the middle ear by means of the air-douche or by suction. As a general rule, incision of the membrane is neither advisable nor necessary, for serous exudation does not tend to become purulent; and, except in the cases where considerable distension is found, this is the case in the bulging drum referred to as occurring in children, as they are semi-chronic, and the continued prehension of the membrane will leave it very ill able to resist the least microbic infection of the cavum tympani; otherwise it is only when a more speedy cure is demanded, or when the mucus is very thick and cannot be otherwise got rid of, that incision is permissible; but in the exceptional cases incision is imperative. (For a description of paracentesis, see p. 196.) Rather than the usual incision, it is advisable in this complaint to make the crescentic incision close to the lower edge of the drum, and as it is very difficult to dislodge this thick mucus, even through an opening so made, it will often be found necessary to insert a small fine probe with its extremity hooked, in order to extract the tenacious mucus which cannot be expelled by the air-douche. If an incision has been made, the after-treatment must be carried out with the strictest antiseptic precautions.

This serous catarrh of the middle ear tends, if recurrent, to degenerate into a chronic condition, and so may form one of the causes of chronic middle-ear inflammation.

CHAPTER IX

CHRONIC NON-SUPPURATIVE DISEASES OF THE MIDDLE EAR

It was customary until comparatively recent years to group under the comprehensive title of chronic dry catarrh at least two distinct affections. The combination of old observations with recent work now makes it possible to distinguish more clearly, and to describe with some accuracy, the two diseases to which we have referred—namely, a chronic catarrhal or subinflammatory process, termed 'otitis media chronica adhesiva,' and a specific condition, the origin of which is but partially understood—namely, otitis media sclerosa. As will be seen, these two complaints may coexist in the same patient, the one or the other predominating.

Otitis Media Chronica.

Chronic catarrhal otitis media—otitis media chronica adhesiva vel hypertrophica—is a progressive, insidious, and subinflammatory affection of the middle ear, consequent upon extension of so-called catarrhal inflammation from the mucosa of the naso-pharyngeal space, which involves, firstly, the Eustachian tube, and eventually the middle ear. This disease is found at all periods of life, though it becomes more common as middle age approaches, and then diminishes in frequency. There is strong evidence that heredity plays an important part in the production of this complaint, although in this instance the ancestral influence is more plainly noticeable in the tendency to the development of adenoid vegetations in the naso-pharynx. Heredity has also a share in the production of the highly arched palate and narrow facial development, both of which tend to an undue contraction of the interior of the nose. The development of adenoid vegetations in the naso-pharynx is undoubtedly more common in civilized than in uncivilized races, for, at the same time, the infections of all sorts are more common, and, consequently, as civilization advances in any race, so will the prevalence of adenoid vegetations become more marked, the more so if, at the same time, the climate is such that the air is frequently highly charged with moisture.

COURSE AND SYMPTOMS.—The onset is gradual, and the affection is not infrequently at first unilateral, though after a certain lapse of time the other ear becomes involved. This, however, may not occur until the disease has obtained a considerable hold on the one first affected. The ear affected later is influenced by the tendency which exists for the sides to synergize in all those cases of middle-ear disease not due to the effects of suppuration. It will be noticed in all instances in which this sympathy occurs, whether in this disease or in others to be considered later, that the ear last affected is commonly the one least amenable to treatment. General conditions of the system, such as anæmia and gout, the effect of malarial poisoning, dyspepsia and constipation, all have unfavourable effects on patients suffering from this complaint. In common with other chronic non-suppurative diseases of the middle ear, the influence of obstructed nasal respiration, whether in the nose or naso-pharynx, is most marked.

Deafness and noises in the head are the principal symptoms of this disorder, to which in the later stages may be added vertigo. In the first instance, the patient will notice a transient deafness occurring whenever he is afflicted with a nasal catarrh; such an attack will present the symptoms alluded to under acute obstruction of the Eustachian tube, and also those of acute serous catarrh, though without any serous fluid being seen in the ear. The deafness may be accompanied by tinnitus, but the patient rarely seeks relief unless, on the subsidence of the catarrh, his hearing-power is diminished. When he does seek medical help, it is for symptoms due primarily to obstruction of the Eustachian tube, secondarily to the effects of this obstruction on the middle ear, or it may be to the consequences of inflammatory and sub-inflammatory attacks in the cavum tympani. The results are the formation of adhesions and thickening of the mucosa, which interfere with the proper movements of the drum and ossicles, and passage of sound-waves through the drum. In others an atrophic condition is noted, and the membrana tympani is extremely attenuated either wholly or in part. Another result of these conditions is the excessive concavity of the drum and retraction of the malleus, together with contraction of the tensor tympani muscle and of the ligaments of the malleo-incudal joint. The patient notices that after each successive cold, with its accompanying deafness, the tendency to recovery of the hearing is delayed, and eventually the recovery is not complete. The recovery of hearing after the cold is often ushered in by a sudden noise in the ear, frequently described as a loud report. This is due to the passage of air through the previously blocked Eustachian tube. The first indication that the hearing has not returned to the normal condition is a difficulty in grasping and comprehending general conversation, and perhaps a tendency to carefully present one ear to persons with whom the patient has to converse. This gradually increasing deafness may have existed for several years before he seeks relief—that is to say, before it has caused him any real inconvenience. Sufferers from this complaint, if previously possessed of a musical ear will not infrequently suffer the most intense discomfort and annoyance from music which before had given them much pleasure, and sometimes these feelings become so great that they are absolutely unable to listen to music in any form with satisfaction. This condition forms a variety of hyperæsthesia acustica, and is often noted with other sounds besides those of music, especially in persons of a neurotic temperament. In the earlier stages of the disease deafness is very variable, disappearing frequently with a sudden noise like a small explosion, and varying with the state of the atmosphere, the patient frequently becoming deafer when the atmosphere is surcharged with moisture. Even in the earliest stages, however, if such a patient be examined carefully between the attacks, both subjective and objective symptoms may be demonstrated. The malleus will appear retracted, and the undue concavity of the membrane is demonstrated by an alteration in the cone of light. Occasional slight pain is complained of either in the ear or behind it, though this is more frequently a dull ache than actual pain, and it may last for some time. It is never severe, and is more common in anæmic patients.

Autophonia (an undue perception of the sufferer's own voice), paracusis Willisii (the better appreciation of sounds in a noise, and paracusis loci (the inability to locate sounds) are three symptoms which are frequently found in this complaint, though paracusis Willisii does not occur unless there are conditions which prevent due movement of the ossicles, especially those of the stapes.

The tinnitus of which patients suffering from this disease complain is of a hissing or singing character, while an occasional variety of tinnitus, often a later symptom, is a loud and intermittent musical sound. Tinnitus is rarely constant in the earlier stages, and is not troublesome; but as the disease progresses it may become a never-ceasing and distressing factor. It increases in volume or intensity, and patients may complain that they are unable to sleep on account of it, and that it is worse, or appears to them to be worse, at night or in the early morning. Mental and bodily fatigue, derangements of the general health, and stimulants (alcohol, coffee, etc.), are common causes of an accentuation of these irritating noises.

Slight vertigo is sometimes found as an early symptom, but tends to disappear without treatment.

The tympanic membrane in simple adhesive or catarrhal otitis media is thickened, and appears whiter than normal, is cloudy or streaky, occasionally almost parchment-like in appearance, though it may be thickened only in parts, and have areas of greater or less extent which remain unaffected. Should this be the case, these unaltered areas will usually be excessively depressed, and if they are of small size they will appear like dark holes in the mucous membrane (Plate II., Figs. 3, 4, 5, 6). Calcareous patches are frequently observed as well as patches of local atrophy, though whether [illegible] changes are due directly to the disease appears doubtful [illegible] they are found in quite young children, and frequently [illegible] portion of the membrane which may remain in conditions of suppurative otitis. The membrane is very rarely normal in appearance, and when so it does not retain its physiological curvature. In very severe or old-standing cases, the drum is at times so retracted that in places no space exists between it and the inner tympanic wall ; in fact, the membrane is sometimes seen tightly adherent to the inner wall.

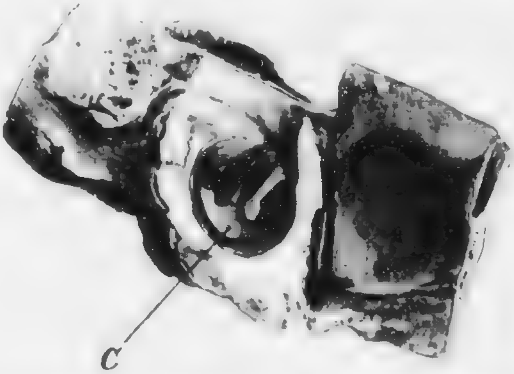


FIG. 41.—CALCAREOUS DEGENERATION OF THE TYMPANIC MEMBRANE.
C. Calcareous plaque.

As the inflation of the ear in this disease tends to improvement in hearing, patients not infrequently perform, either intentionally or by a violent blowing of the nose, Valsalva's experiment *i.e.*, auto-inflation of the tympanum. If this act be frequently repeated, it may cause an undue distension of the more lax portion of the membrane in the posterior and upper segment, and so cause this area to appear to the observer after inflation as a convex protrusion bleb-like in appearance, or, when the tympanum has not been inflated, as a concavity in which the membrane is lying upon the head of the stapes and long process of the incus.

The handle of the malleus occupies, in all but the earliest stages, an abnormal position—that is to say, it will either be retracted directly inwards so as to appear foreshortened to the observer, or it will approach the posterior edge of the tympanic membrane. In the former instance the retraction may be so great that the tip of the malleus comes in contact with the promontory, and, should it remain there for a sufficient length of time, will become firmly adherent, just as the tympanic membrane itself becomes attached to the long process of the incus under similar circumstances. When the malleus is drawn backwards, towards the posterior aspect of the membrane, it may occupy any position between the normal and one in contact with the posterior fold. The mobility of the malleus is tested by means of Siegle's speculum, which will show in every case that the range of movement is diminished, and that in a large number of instances this diminution has become absolute. It may be remarked again that the difficulty in appreciating absolute fixation of the malleus is due to the fact that the membrane moves freely over its upper two-thirds, and that the posterior segment bulges forward when the air is rarefied, an appearance which is apt to convey the impression that the malleus itself is mobile. The cone of light in otitis media chronica adhesiva is never normal; it is altered both in direction and in form. It may be entirely absent from its proper situation, and replaced by a spot of light in an absolutely abnormal place. In such cases the membrane will lie almost entirely on the inner wall of the tympanum. In the earliest stages the cone forms a less obtuse angle with the handle than normal should this structure occupy a position more posteriorly than it ought; if the handle is retracted directly inwards, the cone of light becomes more horizontal than normal—in other words, the angle is rendered more acute. The cone of light itself will not reach so nearly to the periphery of the membrane. It may be broader than usual, may be divided into two parts, consisting of a bright point close to the umbo and a streak midway between this and the periphery, or it may be represented only by a bright spot at the tip of the malleus. In advanced stages the posterior fold of the membrane will be unduly prominent, appearing like a bright white crescent in those cases in which the handle of the malleus has a position of extreme retraction (Plate II., Fig. 9).

The causes of these changes in the tympanic membrane are twofold. The thickening of the drum is due to recurrent attacks of inflammation affecting its inner mucous surface, and the retraction of the membrane and alteration in the position of the handle of the malleus and of the cone of light are supposed to be primarily due to the diminution of the atmospheric pressure within the tympanum, the external pressure remaining the same. Consequently the drum is, as it were, pressed inwards, for, during the obstruction of the Eustachian tube, the air contained within the cavum tympani becomes absorbed or evacuated by clearing the naso-pharynx to a greater or less extent according to the duration of the obstruction. The subsequent contraction of the tendon of the tensor tympani and of bands of adhesions within the tympanic cavity, as well as the contraction of the ligaments of the malleo-incudal and stapedial joints, and also the want of resilience in the tympanic membrane, all tend to prevent spontaneous restoration of the drum to its normal condition.

The state of the Eustachian tube, as well as the condition of the nose and naso-pharynx, must be carefully noted. The patency of the Eustachian tube is determined by the effects of inflation upon the drum and by the sounds observed by means of the auscultatory tube. Inflation is always better performed through the catheter, as it enables the observer to hear more distinctly abnormal sounds than when politzerization is employed. The sound heard through the catheter when inflating an ear affected with a catarrhal otitis media may be best described as distant and also as small or fine in volume; and here it should be remarked that a catheter of large calibre will permit a more accurate estimation to be made than does one of small size. Whatever sized catheter is used for diagnostic investigation, the same calibre should be adhered to afterwards. The effect of inflating the tympanum will, except in the later stages of this disease, give improvement in hearing-distance—an improvement which, though it varies according to the state of the cavum tympani and its contents, as well as to the amount of contraction and adhesions present, will probably be increased at each successive visit. The duration of this improvement will depend upon whether or not the tensor tympani tendon is permanently contracted and also upon whether there are many bands of adhesions fixing down the stapes. In all probability the degree of amelioration is also influenced by the amount of contraction present in the ligaments of the small joints, demonstrated by the amount of mobility the malleus exhibited with Siegle's speculum.

TUNING-FORK TESTS, in the early stages, will show either normal bone-conduction, or, more commonly, a slight increase, less often a diminution. The increase in bone-conduction is often permanent in an uncomplicated case, being probably due to some alteration of the pressure in the labyrinthine fluids, or irritability of the auditory nerve. The air-conduction, by the tuning-fork tests, will be lowered to a greater or less extent, and the lowest musical notes are lost first in this disease, whilst the higher are longer preserved. When the disease is unilateral, Weber's test will show the sound referred to the diseased ear, though this test becomes useless when both ears are involved. The diminution in the upper part of the scale is best determined by that form of Galton's whistle called the 'Galton-Edelmann whistle,' or 'Pfeiffer,' and will be found to be extremely slight; the loss of perception of the lower tones will be demonstrated by the use of low-pitched tuning forks, and, as a general rule, this loss increases with the progress of the disease. In the later stages, when the stapes is fixed in the fenestra ovalis, bone-conduction may be diminished to a moderate amount. Should secondary labyrinthine changes occur, bone-conduction will be much shortened, but in uncomplicated cases Rinne's test is negative, groups α, β, and γ of my subdivisions. The watch and acoumeter will be heard at a shorter distance than usual, and when inaudible on the mastoid will be heard when applied to some other part of the cranium, as the teeth or the zygoma.

Whispered sounds are lost earlier and to a greater proportionate extent than they are in nerve cases.

If the stapes becomes ankylosed by fibrous or cicatricial tissue-formation with the niche of the fenestra ovalis, the following signs, together with a negative Gellé's test, will be of value. These consist in a shortened bone-conduction, a markedly double negative Rinne, together with extensive defect in air-conduction at the lower end of the scale.

Vertigo, or giddiness, is a late symptom of this disease, but may become so severe and distressing that the patients have attacks markedly resembling those of Menière's disease (*vide* p. 254), and in which they may stagger or even fall down suddenly. A feeling of nausea is sometimes an accompaniment of these seizures. The uncertainty of these paroxysms in nervous patients tends to prevent their going out of doors unaccompanied, and often culminates in the condition known as agoraphobia, a condition necessarily aggravated by the deafness.

The nose and naso-pharynx always exhibit changes indicative of chronic inflammation. The nasal mucosa is hypertrophied, the nasal chambers irregular and narrowed, whilst the posterior extremities of the inferior turbinated bodies are usually hypertrophied to a greater or less extent. The naso-pharyngeal mucosa shares the hypertrophy, and is reddened, and in young persons adenoid vegetations are almost invariably present. Granular pharyngitis, or lateral pharyngitis, are rarely absent. Pregnancy and lactation appear to have an extremely deleterious influence in such cases.

DIAGNOSIS.—Diagnosis in this complaint, whilst simple in uncomplicated cases, becomes more and more difficult according as the disease is complicated with a greater or less amount of otosclerosis, and it has further to be distinguished from otosclerosis and those rare conditions in which obstruction of the Eustachian tube appears to have no permanent ill-effect upon the middle ear structures, and is not accompanied by inflammatory action within the cavum tympani.

The objective appearances of the drum in this disease have been described. In uncomplicated cases of otosclerosis the drum is practically normal in colour and concavity; in its earlier stages a reddish blush appears in the region of the promontory. As there exists a large number of instances in which otitis media adhesiva and otosclerosis coexist, the border-line between these two diseases is hard to define with practical accuracy, and there are a large number of cases in which the appearance of the drum will not render any valuable assistance, even though it may present the appearances considered pathognomonic of either. Reliance must be placed upon the tuning-fork tests, as in true chronic Eustachian catarrh there is usually a tendency to prolongation of bone-conduction in its earliest stages (Rinne γ), and as the disease progresses the tendency to a minus bone-conduction becomes very pronounced (Rinne ζ); whereas in otosclerosis, as apart from disease of the labyrinth, from the moment the disease becomes capable of detection, bone-conduction is either markedly prolonged (Rinne ϵ) and air-conduction is diminished, or bone-conduction is diminished (Rinne ζ), when the labyrinth is probably involved. In adhesive catarrh the Eustachian tubes are diminished in calibre, while in otosclerosis they are more patent than normal.

TREATMENT.—The treatment will be considered under (1) administration of internal remedies, directed towards the relief or cure of the deafness and tinnitus; (2) the restoration of the permeability of the Eustachian tube and of mobility to the malleus and stapes, and assistance in the return of the drum and middle ear to a condition of usefulness; and (3) the correction of abnormal conditions in the nose and naso-pharynx.

Administration of Drugs.—The remedy most generally serviceable is strychnia. It should be administered in doses of increasing strength, commencing with $\frac{3}{100}$ grain in the female and $\frac{4}{100}$ to $\frac{5}{100}$ grain in the male, augmenting the dose by $\frac{1}{100}$ grain every second or third day, either until the limit of toleration is reached, or until the patient is taking a dose of $\frac{1}{10}$ to $\frac{15}{100}$ grain three times a day according to the sex. This remedy will be found extremely useful both in improving the hearing-power and in diminishing tinnitus in a large number of cases. Where this drug fails to relieve the tinnitus, dilute hydrobromic acid in ½ or 1 drachm doses three times a day, either alone or combined with strychnine, is occasionally helpful; and as an alternative bromides may be administered at night.

Another very serviceable remedy for the relief of subjective noises is valerian administered in full doses, and best in the form of one of the valerianates or the ammoniated tincture; whilst in anæmic patients arsenic or iron is indicated, and in gouty patients citrate of lithia and the daily use of Carlsbad salts. At the same time any digestive disturbances must be attended to. Thiosinamine and fibrolysin are said to be at times very useful, and may be tried when the malleus is immobile or when there is reason to expect the presence of cicatricial tissue in the cavum tympani if other treatment fails.

The only articles of diet which appear to be detrimental are coffee, alcohol, and, perhaps, pepper. Excessive cigarette smoking should be prohibited, chiefly on account of the irritation it causes in the naso-pharynx.

Inflation.—In the majority of cases especially in the earlier stages of the disease, the major part of any improvement is effected by the use of periodic inflation. To obtain this end there are three recognized methods: that of auto-inflation—the process of Valsalva—politzerization, and inflation through the catheter.

With regard to auto-inflation, it should *never* be prescribed, as the relief obtained by the patients induces them to repeat the process with ever-increasing frequency, and in a considerable number of cases it has a very deleterious effect, stretching unduly the posterior segment of the drum. It will eventually cause increased hardness of hearing by the relaxed tissues falling and lying upon the long process of the incus and the head of the stapes.

Whether politzerization or catheterization is resorted to must depend to a certain extent upon the skill of the operator, but the use of the catheter enables a more accurate employment of the air-current.

The ear should be inflated not oftener than three times a week, and persisted in for about six weeks, or less if the patient ceases to improve. The course of inflation is to be repeated at the expiration of about four weeks, and may be continued as long as improvement is manifest. After this second course of treatment, or sometimes at the end of the first period, the patient will have obtained what may be termed his maximum amount of hearing. This amount of hearing is retained for a longer or shorter period, and the patient is to be instructed to immediately return for treatment at the first indication that he is again becoming deafer.

In favourable cases the length of time which elapses before the patients notice a return of their deafness will increase, and eventually the condition of the patient will remain satisfactory for several years at a time.

Should no improvement be obtained after two to four weeks' treatment, no good effect is likely to be produced by continuing inflation for a longer period; but if no beneficial effect accrues, other adjuncts to this treatment may be employed. These are the injection through the catheter into the middle ear of oily fluids, or aqueous solution and vapours. Of the former, highly rectified paraffin (petroleum molle), either alone or containing iodine or menthol in solution, the former in the strength of ½ per cent. and the latter of 1 per cent. Of the fluids, solutions of iodide of potassium and bicarbonate of soda, 1 and 5 per cent. solutions respectively, with or without the addition of a little glycerine, are useful.

The method of employing these remedies is as follows: The catheter having been passed and ascertained to be in position by a preliminary use of the air-bag, 1 to 3 minims of the fluid selected are injected into the catheter from a Pravaz syringe, and the air-bag again employed. If as small an amount as this is used, it is blown out of the distal end of the catheter in the form of a spray, and will penetrate and permeate the whole cavity of the middle ear. If more fluid is used, the major part of it will find its way down the Eustachian tube, and that which is driven into the tympanum will gravitate to the bottom of the cavum tympani, and as long as it remains there will cause a temporary increase of deafness, and is not productive of any better results than when the smaller amount is employed. These solutions should be employed each time the catheter is used—that is to say, three times a week.

It is in certain conditions of adhesive middle-ear disease that the Eustachian bougie gives very good results. The indications for its use are the bad entry of air into the middle ear when inflating through the catheter, and improvement in the hearing, but only of short duration, after inflation. The bougie should be used two or three times, and the largest size employed, and kept *in situ* for three to five minutes each sitting, and a little oleum petrol injected as described on the previous page.

Vapours.—The following vapours are employed cold, advantage being taken of their volatility: acetic ether, ethyl iodide and ethyl chloride; they are used either alone or mixed with acetic ether and tincture of iodine, a few minims being dropped into the air-bag before inflation. This is a proceeding often of considerable benefit in the special treatment of tinnitus.

Nascent ammonium chloride vapour inhaled or exhaled through the nose, or taken into the mouth and passed through the nose, acts locally on the naso-pharyngeal mucous membrane; by reducing or curing the catarrhal state of this region it often improves hearing, and may be safely recommended.

Methods of Treatment from Without.—The foregoing methods may be considered as treatment from within, inasmuch as they act on the cavum tympani and on the inner surface of the membrana tympani. Those about to be considered are employed on its outer surface viâ the external auditory meatus. They are rarefaction of the air in the external meatus, pneumo-massage, and the use of the pressure-probe of Lucae.

The rarefaction of air in the external meatus is a proceeding which is often of considerable benefit, contributing towards the more forcible stretching of adhesions between the membrane and the inner wall of the tympanic cavity, and also aiding in the stretching of the contracted tendon of the tensor tympani. This method is particularly valuable, in common with the use of the pressure-probe, in cases where the handle of the malleus is partially or entirely fixed. The method of rarefying the air in the external meatus is by the use of the raréfacteur of Delstanche, or, by what is equally effective, the insertion of the rubber nozzle of a compressed Politzer's bag into the external meatus, and allowing it to partly expand. Whichever form is used, great care must be taken that the suction is not too violent. The best method of controlling this suction is by attaching the raréfacteur to a Siegle's speculum, observing the effect on the drum, and regulating the pressure according to the effects observed. The dangers to be apprehended are rupture of a bloodvessel in the membrane, or rupture of the membrane itself. The former is a matter of no permanent moment, but will delay the local treatment for some time, and may cause more discomfort than is desirable ; while rupture of the membrane itself is a much more serious consequence, since, should it be neglected, suppuration may ensue, and the case become converted into one of chronic suppuration in the middle ear, with all its attendant dangers.

If this form of treatment prove beneficial, it should be repeated daily for some time, and may be delegated to the patient's own use, provided that he is carefully instructed as to the necessity of avoiding any effect exceeding slight discomfort from the amount of suction employed. The séances should not exceed half to one minute to commence with, and five minutes at the outside when the ear has become tolerant of the strain.

The use of Lucae's pressure-probe is described on p. 74. It is well to anæsthetize the ear by the use of aniline oil cocaine solution. The pressure should be intermittent, and not repeated until any inflammatory disturbance that may have been caused by its use has subsided, nor should it be employed for more than a few minutes at a time. The total duration of the course must be determined by results.

If these lesser or milder measures prove unsuccessful, the malleus may be forcibly mobilized by exerting sufficient pressure on the short process by means of the probe under cocaine or general anæsthesia.

Oto-massage or pneumo-massage is described on pp. 72 and 73, and it is especially necessary to bear in mind the rules laid down with regard to its employment. It may be employed daily, and is well managed by patients themselves. It should not be used at first for a longer duration than one minute, and should not be persisted in without a relatively long period of disuse for more than four weeks.

The use of this method is occasionally followed by a diminution of the hearing-power, which must be taken as an indication for the prompt discontinuance of the treatment.

In all cases attention should be directed to the state of the nasal passages, free nasal respiration being essential to the relief, cure, or prevention of recurrence of chronic otitis media non-suppurativa.

FIXATION OF THE MALLEUS

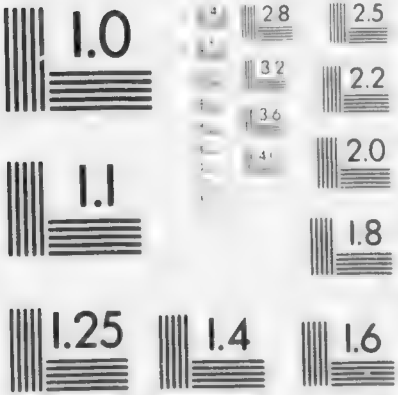
Stretching the Tympanic Membrane.

Fixation of the malleus is a very common occurrence, and is often the result of a transient otitis media non-suppurativa, and is probably a condition which of itself but little injures the acuity of audition—that is to say, at any rate, as far as ordinary business and social life is concerned. But if the patient at the same time has obstruction to his nasal respiration, and especially if that obstruction be on the same side, then the frequent violent nose blowing will gradually cause a stretching of the posterior half of the tympanic membrane on the affected side, and when this has become just sufficient to cause the membrane to come in contact with the bony portions of the incus and inco-stapedial joint during the time that the membrane is not bulged outwards by the inflation caused by the nose blowing, some dulness or hardness of hearing will be developed. The patient then will probably discover for himself, or he may unfortunately be instructed to employ the so-called 'Valsalva' experiment, thereby giving himself temporary increase in hearing. This in itself tends to make the patient employ the method more and more frequently, thereby not only stretching the drum more, but at each time that he does so, he causes a concussion of the labyrinth, slight and transient at the first, but always with a tendency to leave behind some slight injury to the delicate structures of the cochlea, or even of the canals and vestibule. Thus the fixation of the malleus may be the indirect cause of a chronic concussion of the labyrinth, and a gradually increased hardness of hearing, which is entirely due not to the fixation of the malleus, but to the nasal obstruction.

TREATMENT.—Treatment here may be divided under three headings: that directly to the malleus, directly to the nose, and directly prophylactic. Thus we may mobilize the malleus by direct pressure (see Operations). Besides the mobilization of the malleus, and also, preferably, long before, measures should be taken to, as it were, restore the resilience of the drum; rest alone will sometimes do this, but the old treatment of painting that portion of the stretched tympanic membrane with collodion is perhaps unequalled, though it was the custom a great many years since to paint this relaxed drum with strong solutions of nitrate of silver, a pernicious treatment which has of late been revived. We must remove the enlarged posterior ends of the turbinates—if they exist—and otherwise render the nasal passage patent. But what is of the greatest importance is that we must instil into the patient's mind the absolute necessity of never blowing the nose, unless the nose is blown without any compression of the nares.

MICROCOPY RESOLUTION TEST CHART

ANSI and ISO TEST CHART No. 2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APPLIED IMAGE Inc

CHAPTER X

CHRONIC SUPPURATIVE DISEASES OF THE MIDDLE EAR

Chronic Suppuration of the Middle Ear—Otitis Media Suppurativa Chronica.

SUPPURATION of the middle ear is by general consent considered chronic after it has been in existence for more than six weeks. This is a purely arbitrary division, but in practice some such fixed period of time is advisable. It may, therefore, be viewed as the sequel to an acute middle-ear suppuration which has ceased to show any evidence of active inflammation. No doubt isolated cases occur in which the acute disease lasts considerably longer than the time given. Tuberculosis is the most important cause of such continuance, and this variety has been considered under the heading of Acute Tuberculous Disease of the Middle Ear.

As has been seen, all chronic otorrhœas which have the source of their discharge in the middle ear are the sequels to inflammatory disorders of the nose and naso-pharynx. Infantile otorrhœa is most commonly, one can almost say invariably, accompanied by the swelling of the pharyngeal tonsil, and it is to the persistence of this enlargement that the continuance of middle-ear suppuration in childhood is largely due. In adults it is less common for a primary acute inflammation to merge into a chronic one, chiefly for the reasons that it is more easily and efficiently treated, and that the pharyngeal tonsil is rarely hypertrophied, so that the middle ear drains more readily into the naso-pharynx. In Fig. 42 is given a diagrammatic representation of a section through the external meatus, middle ear, and Eustachian tube. From this it will be seen how the drainage of the middle ear is performed by the Eustachian tube. If the Eustachian tube is unable to perform its function on account of its orifice being closed by pressure from adenoid growth in the naso-pharynx, and if there is at the same time suppuration in the middle ear and its subsidiary cavities, an accumulation of pus occurs in the cavity of the middle ear, until the retained secretion has reached in the first instance the lower border of the tympanic perforation, wherever this may be situated, and in the second place the pus has escaped through the perforation into the external meatus, it will only appear at the external orifice when it has reached the highest

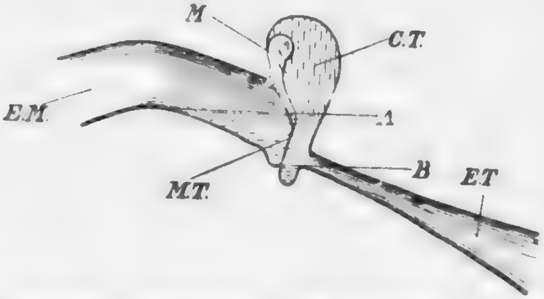

FIG. 42.—DIAGRAM ILLUSTRATING THE INFLUENCE OF ADENOID VEGETATIONS IN THE NASO-PHARYNX ON SUPPURATION IN MIDDLE EAR.

EM, External meatus; *M*, malleus; *MT*, tympanic membrane; *ET*, Eustachian tube; *A*, level of fluid in external meatus and cavum tympani; *B*, level of fluid in ear when Eustachian tube is patent; *CT*, cavum tympani.

level in the floor of the canal (A). If the perforation lies below this level (A), the whole cavum tympani will be kept constantly full of pus, and the suppuration must continue so long as such a condition exists.

SYMPTOMS AND SIGNS.—Purulent discharge, sometimes offensive, occasionally stained with blood, from the external meatus; perforation of the membrana tympani; deafness. Patients often complain of giddiness, a disagreeable taste in the mouth, noises in the ear, headache (general or localized), and an irritability of temper. They are not uncommonly unable to concentrate their thoughts upon any subject.

Chronic Sepsis.—When suppuration has existed for a considerable period of years, the patients often have an extremely sallow complexion, and suffer from a constant or chronic malaise, which may be assumed to be due to a chronic sepsis, kept up by frequent absorption of small amounts of toxic products. In long-standing cases, or in cases where suppuration is proceeding rapidly, other symptoms may be noticed, and they are usually of serious import. Fixed pain in the ear or over a localized portion of the mastoid, nystagmus, vomiting and facial paralysis, may be instanced in this connection.

Discharge.—Though usually purulent, it may be quite clear and watery. An offensive odour is often very noticeable, and the quantity of the discharge varies within wide limits, from a scarcely perceptible moisture of the meatus to a profuse flow. Its consistency may be increased so much as to look like treacle, in this respect resembling acute otorrhœa.

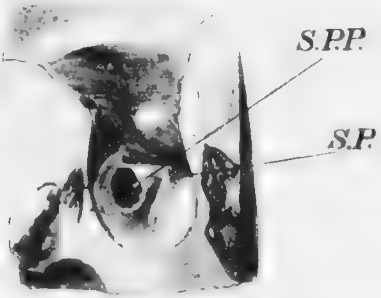

FIG. 43.—PERFORATION OF MEMBRANE IN POSTERIOR SUPERIOR QUADRANT.

SPP, Perforation in superior posterior quadrant; *SP*, processus brevis.

Intermittent discharge may be due to a lighting-up of the old trouble after a temporary cessation, or to the effects of accumulated cholesteatomatous material; in the former case exacerbations of pain are frequent. Recurrent discharge often preceded by either ear-pain or headache. A sudden cessation of discharge sometimes occurs simultaneously with the onset of some of the severe septic intracranial lesions.

Perforation of the Membrana Tympani.—It must not be taken as a *sine quâ non* that there should be in every case of suppurative otitis media a perforation of the membrana tympani, but the instances in which there is no such perforation are of very considerable rarity. In place of a perforation in the membrane a sinus opening into the external meatus is present, which is connected directly or indirectly with the cavity of the middle ear.

When a perforation is present, its size and situation varies. The drum is rarely absolutely destroyed, for even in those cases in which the greatest destruction of the membrana tympani has taken place, there is a pa t, at least, of a narrow border left at the periphery, where the membrane is strengthened by the presence of a few cartilage-cells and also where its nutrition is greatest.

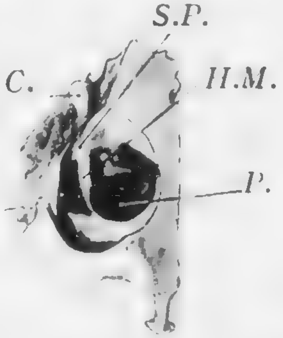

FIG. 44.—PERFORATION OF MEMBRANE IN POSTERIOR INFERIOR QUADRANT.

C, Head of malleus ; *SP*, processus brevis ; *HM*, handle of malleus ; *P*, perforation.

Cases of perforation of the membrana tympani may be conveniently divided into two great classes—perforation of the membrana propria, or the true drum, and perforations of the membrana flaccida, or Shrapnell's membrane.

Perforations of the true drum differ in import according to their situation. They may be said to increase in seriousness when, considering those situated in the anterior superior quadrant as the least serious, they are taken in the following order, passing round the drum : Anterior superior, anterior inferior, posterior inferior, posterior superior. This seriousness of import is applicable as regards the prospects of cure, hearing-power, and the extent of the destruction of structures within the middle ear. In order to obtain a clear view of the membrane it is necessary to remove from the external meatus all traces of pus, epithelial débris, or wax. This may be accomplished either by gently syringing the ear with an antiseptic solution, which is best done with an indiarubber tube fitted to the nozzle of the syringe, or by means of cotton-wool mops. The patient should invariably be seated, the solution used in the syringe of a comfortable temperature, and no great or sudden force imparted to the stream of lotion. Even with these precautions severe vertigo will occasionally

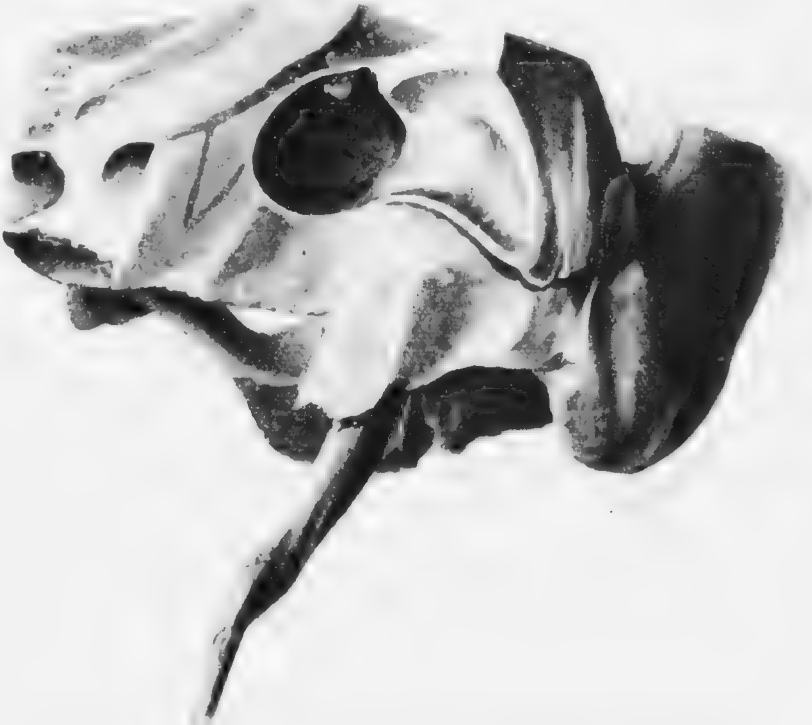

FIG. 45.—OTITIS MEDIA SUPPURATIVA: COMPLETE DESTRUCTION OF M.T. WITH CICATRIZATION.

be complained of; it passes off in a short time. If cotton-wool mops are employed, they should be attached to a proper carrier; and to avoid soiling the fingers, the used wool may be removed either by use of a soiled wool-receiver or by a pair of forceps. Brisk movement of the mop in water loosens its attachment to the carrier and facilitates detachment. When the passage has been carefully cleansed, all moisture must be removed by pledgets of cotton-wool, as was described under General Treatment.

It is well to remember that, as a result of either method of cleansing the ear, the tissues of the drum and deeper parts of the meatus will be somewhat injected, and proper allowance must be made for this hyperæmia.

Perforations, if large, are easily detected, and through which the observer in the majority of instances is able to see a part of the inner wall of the tympanum (Plate III.). The part seen will necessarily depend upon the site of the perforation. If it is situated in the posterior inferior portion, he will see the promontory, and perhaps the foramen rotundum, appearing as a dark shadow posteriorly. If the posterior superior quadrant is gone, or if the perforation embraces that area, he may see the long process of the incus, the stapedius tendon (Plate III., No. 7), and occasionally the bony prominence of the Fallopian canal. In a case of long-standing suppuration the mucous membrane of the inner tympanic wall will have a pale yellow colour, or it may appear flaky and white when it is undergoing the so-called cholesteatomatous change. In cases that are more recent, or more active, the mucous membrane will appear pink (Plate III., No. 8), and should there be a tendency to granulation, nodes may be observed on it, not unlike the surface of a raspberry, but of a brighter red hue. When the perforation is small, so that little light is able to penetrate through it into the cavity of the middle ear, the perforation appears as a dark point (Plate III., No. 9); to distinguish it from a depressed area of attenuated drum membrane, there will be no minute light reflex visible within it, as there usually is in such a condition of the membrane, but the use of Siegle's speculum or the inflation test will render the diagnosis clear. The edges of the perforation convey valuable hints upon the state of the case. A perforation which has existed for a considerable period, with discharge of not a very irritating character, will have edges thick and callous. Provided there is a tendency to the closure of the perforation, or if the discharge is of a very irritating character, the edges will be pink and thin; at other times the margins will be sharply cut, this sharpness of definition being usually met with in perforations in which the discharge is either slight in amount or has not existed for long periods.

Perforations in the drum are usually single, but occasionally there are more than one, and in many instances a second perforation lies in Shrapnell's membrane (Plate III., No. 12); in other cases what was originally a single perforation has been converted into two or more by bridges of tissue having grown across the space.

Perforations in the posterior superior and anterior inferior quadrant are often very difficult to detect, sometimes because they are so situated at the edge of the membrane that they are hidden by the posterior part of the meatus; if their presence is suspected, the upturned edge of a fine probe will afford conclusive evidence, or a tiny speck of moisture may be seen on the upper part of the membrane. In a large number of cases the former is not a perforation of the membrana tympani in the usually accepted sense of the word, for cicatricial tissue binds down the edges of the membranous portions of the perforation to the inner tympanic wall and posterior wall of the aditus, so that pus from the antrum flows directly into the external meatus without actually entering the cavity of the middle ear.

The risk of injury and destruction of any link of the ossicular chain varies both with the duration and with the situation of the perforation in the membrane, one in front of or below the handle of the malleus being comparatively rarely accompanied by necrosis or caries of the ossicles. A perforation of any duration situated in the posterior superior quadrant is invariably accompanied by a carious destruction of osseous structures, the long process of the incus, the incudo-stapedial joint, the stapes itself, or both the stapes and the long process of the incus, being the parts frequently affected. A perforation of Shrapnell's membrane, which has existed for even a comparatively short time, will be accompanied by destruction of the malleo-incudal joint; with a perforation in this region which has existed for some months or more the head of the malleus and the body of the incus will be more or less destroyed, and in rare instances, where a long-standing suppuration in this region has been cured, the malleus and incus will have become ossified together. In Fig. 46 will be seen a diagrammatic representation of the frequency with which various parts of the ossicles are destroyed. In some cases of extensive destruction of Shrapnell's membrane the incus may be entirely destroyed, and only the handle of the malleus left. A method exists of ascertaining whether or not the ossicular chain is complete by gently stroking the drum with a fine probe, when, if the ossicular chain is complete, it is felt, a friction sound is heard; if the chain is incomplete, the movement of the probe alone is felt, but the test is of trifling value.

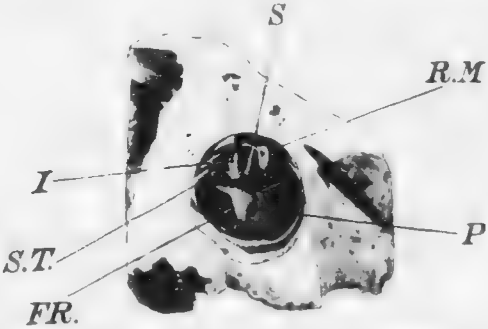

FIG. 46.—TOTAL DESTRUCTION OF MEMBRANE AND HANDLE OF MALLEUS (LEFT).

RM, Remainder of malleus with a filament of tympanic membrane attached; *S*, stapes; *I*, incus; *ST*, stapedius tendon; *FR*, foramen rotundum; *P*, promontory.

When suppuration is profuse a drop of pus may be frequently seen oozing from the perforation, and at times a distinct pulsation is noticed in the exudation. This phenomenon has been considered of some importance as indicating the presence of complications.

Quite frequently the perforation is not visible, either on account of its size or because it is so situated as not to come into view. In such a case the ear is, if necessary, again carefully dried, and an attempt made to draw some discharge through the perforation from the middle ear. If this manœuvre is successful, the site of the perforation is easily located. When the perforation is not so discovered, inflation by means of the catheter will give, in the event of a small perforation, a whistling sound, and in the case of a larger one the air current will strike directly on the observer's tympanic membrane through the auscultatory tube.

COURSE.—The course of chronic otorrhœa cannot be said to tend towards spontaneous cure. Permanent spontaneous cessation of discharge comes about in relatively an extremely small proportion of cases. Cure can be obtained by careful treatment in a fair number of the cases which come under observation; a large number, however, tend to continue or relapse, and of this large class few fail to exhibit complications at one time or another.

The complications, to which reference will shortly be made, may be divided into those which are only hurtful so far as the organ of hearing itself is concerned, and those which, if left untreated, may sooner or later end fatally. As will be seen after a consideration of the possible complications of the disease, no case of discharge from the middle ear should be left without careful and continuous treatment upon ordinary lines; and if a cure cannot be obtained in this way, in no instance should the patient be allowed to continue without having the dangers of his position and the advantages to be derived from operative procedures clearly placed before him.

TREATMENT.—The treatment of chronic suppuration may be divided into attempts to cure the discharge by means of antiseptics or astringents, or by operative measures. The latter are considered, with their indications, on p. 196, *et seq.*

Opinions are largely divided as to the relative advantages to be derived from wet or dry treatment; but, speaking generally, the wet treatment, by which is understood the use of injections, combined with the use of lotions in the form of drops, will as a rule give the more satisfactory results. The lotions which are to be employed are given in the Appendix 9 to 16, and are to be persevered in regularly for a considerable period. Whichever is selected is to be employed with care, the main point being to entirely free from discharge all parts within reach of the stream; consequently sufficient force for this purpose must be used, and the stream directed along the superior or posterior meatal walls, and the ear well dried afterwards. These injections should be used at least three times a day, and the patient should be instructed to attach to the nozzle of his syringe a fine indiarubber tube, which is to be used as already described.

As chronic suppurative otitis media is an extremely intractable disease, it is well to change the lotion at intervals of from four to six weeks, until one has been found which seems to exercise a good influence on the disease, as is shown by the gradual cessation of the discharge and a healthy appearance of the parts.

In every instance the prospect of cure by the use of antiseptics is greatly enhanced if all injections are done by a thoroughly competent person—either a well-trained nurse or the medical man himself; and it is largely due to the want of skill on the part of the individual who is responsible for the syringing that so many cases will not yield to treatment.

Of all the varieties of antiseptics used, biniodide or perchloride of mercury, boracic acid, and creolin and lysol are the more universally serviceable.

After all irrigations, it is of great importance that the middle ear and external meatus be left as dry as possible.

Occasional inflation of the ear after syringing is to be advocated, as blowing out pus from the middle ear into the meatus, and so enabling the antiseptic more easily to penetrate into the deeper parts. Any small granulations or any signs of cholesteatoma will call for appropriate treatment, which will be found described under these respective complications.

Another valuable form of treatment lies in the use of alcohol drops and hyd. perox., 10 volumes, two or three times daily. These may, with advantage, be used after irrigation with an antiseptic solution and subsequent drying of the meatus. A warmed teaspoon is partly filled with the lotion, which is then poured into the ear, or is instilled by means of a medicine dropper; these remain in the ear for twenty minutes, the head being placed with the ear under attention uppermost. These guttæ may be used in conjunction with irrigations, but the ear is to be well dried out before and after they are employed.

Alcohol drops find their chief indication in those cases in which granulation tissue tends to appear; all guttæ give the best results when the destruction of the tympanic membrane is extensive, which enables these fluids to search out the nooks and crannies of the middle ear and attic.

The use of peroxide of hydrogen twice or three times daily, without using any other lotion, is a form of treatment which will frequently give very good results, more especially where slight tendency to cholesteatomatous generation is present or the pus is very thick and tenacious.

The use of sterilized boracic powder, or boracic and iodoform mixed, may be frequently employed with advantage when the destruction of the tympanic membrane is of considerable extent, and may be considered contra-indicated when the perforation is small, and when it is situated high up.

When powders are used they are to be insufflated into the meatus once or twice daily for three days, and then removed by antiseptic syringing, and the ear thoroughly dried before the powder is again insufflated. If this irrigation is not observed, the meatus tends to become occluded with a mass of inspissated pus and boric acid powder.

During the continuance of the local remedial measures general treatment must not be neglected, a careful administration of tonics, attention to the digestive system and excretory functions having an important bearing on the progress of the case. In children the use of cod-liver oil, or preparations of malt, will afford valuable aid, and in patients who suffer with adenoid vegetations their removal must be considered the most important preliminary step.

Chronic Suppuration of the Tympanic Attic.

Chronic suppuration in this situation is recognized by the presence of a perforation in Shrapnell's membrane (Plate III.) together with a history of chronic discharges. Frequently these perforations are partially closed by epithelial débris, and from them at times one or more small polypi may be seen protruding (Plate III., Fig. 10). In order to confirm the diagnosis the bent end of a fine metal probe may be introduced through the perforation, and bare bone sought for at the same time. Perforations in this locality may have existed for a number of years with an exceedingly small amount of disturbance to the hearing-power, and it is due to this fact that patients suffering from chronic disease of the attic are extremely loath to submit to any operative interference suggested for the cure of the discharge. The parts of the ossicles which are destroyed in attic suppuration are the whole, or part, of the head of the malleus, the body of the incus, and its short process. Or the joint between the malleus and incus may be disorganized, with destruction of the articular cartilages. Chronic suppuration of the attic is extremely intractable. This is due to the size of the opening, and to the fact that, although it is apparently in the most dependent part, yet pus may be lodged in various membranous compartments within, from which free drainage is impossible. The disease does not often spread downwards into the cavum tympani, as all the interstices through which pus would have passed are closed by the chronic inflammatory condition of the mucous membrane.

Extension of the disease towards and into the external canal is occasionally found; if so, the lesion is one of the external semicircular canal, and will in most cases be confined to that part of the labyrinth, so that excellent hearing is not incompatible with this condition.

Pathological perforations of Shrapnell's membrane require to be distinguished from anatomical deficiencies. These latter have no significance, being merely errors of development. The pathological perforation is distinguishable by the redness of the surrounding tissues, the presence of detritus or pus in, or the passage of pus through, the opening.

TREATMENT.—The nozzle of a Hartmann's cannula should be introduced into the perforation with the aid of reflected light, and the cavity of the attic thoroughly washed out with an antiseptic solution, lysol, carbolic acid 2 per cent. solution, boric acid solution, or weak corrosive sublimate being all equally efficacious. The treatment must be carried out carefully for many weeks, and the lotions changed fairly often. If no diminution in the discharge occurs, operative procedures should be undertaken. These may be (1) an enlargement of the opening by cutting away the outer attic wall with Krause's forceps; (2) ossiculectomy; (3) the partial mastoid operation. The choice of these procedures will vary according to the experience of the operator (see Operations).

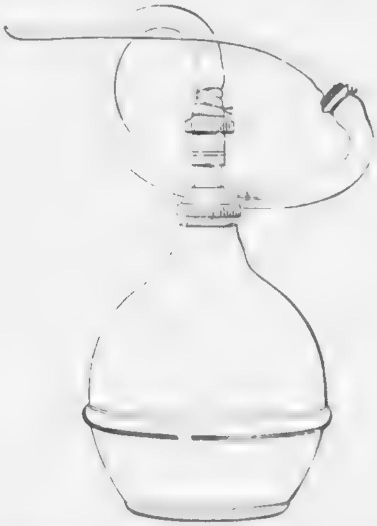

FIG. 47.—PROFESSOR HARTMANN'S ATTIC CANNULA WITH BALL SYRINGE ATTACHED.

As alternative treatment the surgeon may wash through the ear and attic from the Eustachian tube, using either normal saline solution, employing for this purpose a syringe and Eustachian catheter, or the izal oil treatment, recommended earlier, may be tried.

Complications of Otitis Media Suppurativa Chronica.

Eczema of the meatus, vertigo, nystagmus, sickness, pain, headache, tinnitus, granulations and polypus, cholesteatoma, necrosis of the ossicles, necrosis of the temporal bone, necrosis of the labyrinth, external and internal fistulæ, contraction of the meatus, facial paralysis, suppuration within the labyrinth, lateral sinus pyæmia, extradural and intradural abscess, meningitis, cerebral abscess, and cerebellar abscess.

Vertigo on Syringing, and Lateral Nystagmus.—When a patient complains of vertigo on syringing the ear, the practitioner should make inquiries as to whether the objects in the room gyrate constantly in the same direction, or if the patient has a tendency to fall in any particular direction. To obtain definite information upon the vertiginous complication, it is necessary that the practitioner himself should syringe the ear ; the solution, to make the test more reliable, should be a little colder or warmer than usual. If the disturbance of equilibrium is general, it may be attributed to pressure on the footplate of the stapes ; if, on the contrary, the objects have a tendency to rotate in the horizontal plane, or if the patient tends to fall towards the side which is being syringed, the lesion is probably in the region of the external semicircular canal. This is corroborated if lateral nystagmus can be elicited, the oscillations in this case being extremely small and transitory in character as compared with those found in meningitis and cerebellar abscess ; at times the vibratory movement is evident in an acute exacerbation of a chronic otorrhœa. These effects are caused either by an erosion of the bony semicircular canal and the consequent exposure of the membranous canal to the hot or cold lotion ; or when nystagmus, due to the ear lesion, is present alone and is not elicited by syringing, it is due to an ostitis extending inwards from the iter or aditus, which compresses somewhat the canal. The difference noted on syringing between a lesion of the bony external canal, and a perforation into it or the vestibule is that in the latter the patients tend to fall away from the side affected. (For further particulars see p. 260).

Granulation Tissue and Polypus.—Aural polypi are composed in every instance of ordinary, and later, of organized granulation tissue, and arise either from ulcers of the mucosa or are exuberant granulations springing from diseased bone.

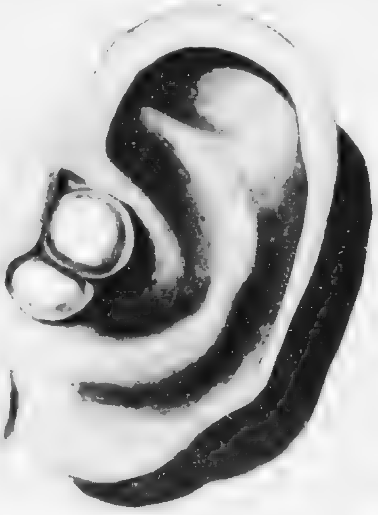

FIG. 48.—AURAL POLYPUS PROTRUDING FROM MEATUS.

The presence of polypus in the ear may commonly be assumed if the discharge is at times tinged with blood. They are not infrequently cast off spontaneously, a cure probably due to a twisting of the pedicle or to its degeneration. They may be removed during syringing, more especially when an india-rubber tube is used, and its end has been introduced beyond the growth. Polypi occasionally cause a series of symptoms quite peculiar to themselves; in these cases, touching the polypus may alone give rise to the most severe vertigo, ending in unconsciousness, whilst nystagmus and sickness are sometimes the result of any application. These polypi arise in the aditus in connection, or conjunction, with a fistulous opening in the bony external semicircular canal. At other times, from their size, they may obstruct the outflow of pus from the ear, and so set up a state of septic auto-intoxication. The polypus must be distinguished from a red and bulging membrane and from the lining membrane of the tympanum, especially that which covers the promontory, when red and thickened and of a granular appearance; it also requires to be distinguished in rare instances from a red and smooth foreign body. A polypus, when entirely within the ear, can be distinguished from a bulging membrane by the fact that the latter is an acute condition, whereas a polypus is comparatively rarely found in an acute otitis media, and by the fact that a polypus can be freely moved about by a probe, and by the passage of the probe all round it; further, if it is soft, it usually bleeds very freely, and when pressed upon does not give a sense of resistance, as does the promontory, whereas a foreign body will usually be hard. Polypi at times project beyond the orifice of the external meatus, growing to a large size. This condition is becoming much rarer in civilized countries on account of the greater appreciation of the gravity of discharge from the ear. Small polypoid growths projecting through Shrapnell's membrane appear as small red masses hanging down above the handle. They occasionally arise at the edge of a fistula in the canal, and then will be found attached to the wall of the meatus when an attempt is made to pass the probe round them.

PATHOLOGY AND HISTOLOGY.—An aural polypus has its origin in a button of granulation tissue, which is almost invariably the outcome of suppurative inflammation. It is, in fact, the 'proud flesh' of our predecessors. The button of granulation tissue takes on exuberant growth; blood-vessels develop within it; its surface becomes gradually clothed with a layer of epithelium, generally squamous, sometimes tending towards the columnar type, especially if the polypus becomes branched and its surface irregular. The future changes which take place are materially influenced by the period occupied by its growth. The first alteration in the histological structure after the development of the bloodvessels is the conversion of the whole mass by gradual stages into a soft fibroma, the leucocytes becoming spindle-shaped cells. A secondary contraction of the older tissues now takes place, and a firmer fibrous structure is attained, which gradually proceeds until the whole polypus is a small pedunculated fibroma. Should the blood-supply of the polypus be free, the growth may either remain a fibroma or take on the characters of an angio-fibroma by excessive development of its bloodvessels. If, on the other hand, the bloodvessels are insufficient to supply nourishment to the mass, mucoid degeneration takes place, the fibrous tissue apparently becoming resolved by mucoid degeneration, while the connective-tissue elements form the beautiful branching stellate cells characteristic of a myxoma, and the growth is now either a myxo-fibroma or a pure myxoma.

TREATMENT OF AURAL POLYPI.—The treatment of aural polypi must not interfere with the treatment of the disease of which they are a complication. If the polypi are small, and really not more than slightly exuberant granulations, no operative measures are usually necessary. If, however, they are of appreciable size, the sooner such growths are destroyed the better.

No operation for the removal of aural polypi should be commenced until careful antiseptic precautions have been taken. If this be done no ill-effects will accrue. A thorough antiseptic irrigation at the time of operation will be sufficient, but a previous cleansing and packing of the canal with antiseptic gauze is much to be desired, should time and opportunity permit. Polypi may be removed in a large number of cases under cocaine analgesia; but if the patient is nervous, or if touching the polypi gives rise to unpleasant symptoms, resort should be had to general anæsthesia.

In most cases the destruction of the polypi is accomplished either by means of a small snare, or by a curette, though the valuable and curative powers of caustics and astringents must not be forgotten.

If the snare is used, the most convenient instrument is

Grüber's. It is threaded with fine wire. and the loop is regulated according to the size of the speculum used ; it can most conveniently be gauged by tightening the wire round the tip of the speculum next smaller in size. The loop is now bent at almost right angles to the shaft of the snare. and gently introduced round the polypus, as deeply into the meatus as possible. The snare is slowly tightened. and it is better not to cut entirely through the polypus. but rather, when a firm hold is obtained. to pull off the growth by a sharp tug. thus making sure of obtaining the whole of it. Bleeding is sometimes free. but can be controlled by plugging with gauze after the meatus has been well syringed out with a strong antiseptic solution. as 5 per cent. carbolic acid or 1 in 3.000 hyd. perchlor.

When no hæmorrhage occurs, or after it has been checked, the stump of the growth should be touched with Tinct. Ferri Perchlor., or some similar caustic astringent.

Polypi may also be removed by means of a blunt curette. If the curette is used. it should be passed to the base of the growth. within the tympanum. if that is the place of origin, or if the meatal wall be the site of growth. then the curette must be kept as closely applied to the meatus as is possible. The pedicle. or base of the growth. is to be pressed firmly against the meatal wall. and divided by sharply withdrawing the instrument. keeping it pressed firmly against the meatus. This is certainly the more rapid method. and is also the more easily used and is more efficacious when performed under general anæsthesia. but without it is slightly more painful than removal by snare.

After the growth has been cleared away and bleeding arrested. the site from which the polypus sprang. together with any smaller polypi which may have been brought to light. and are too small for removal. should be touched with chromic acid fused on the end of a probe, or trichloracetic acid.

If the patient refuse to submit to any operation. the polypus may be destroyed by means of chromic acid, a slow and somewhat tedious process. except in the case of small growths.

This method of destroying polypoid growths, as practised by Politzer, consists in the application of a single crystal of chromic acid to the polypus. The crystal, if the growth be small, will sometimes cause a complete sphacelus of it. If this favourable result does not happen, when the slough separates the process is repeated until complete destruction is obtained. It is always well to remember that in soft and pedunculated polypi a vigorous use of the syringe will not infrequently rupture the connection of the growth. A very favourite method of destroying granulation tissue and smaller growths is the use of alcohol; any of the lotions in the Appendix 17 to 20 may be employed in the form of drops; 10 to 20 minims should be poured into a previously warmed teaspoon, and then allowed to flow into the affected ear, whilst the head is inclined to the opposite shoulder. These drops should be allowed to remain in the ear for about twenty minutes, repeating the treatment three or four times daily after syringing and drying the meatus.

Cholesteatoma — PATHOLOGY. — Cholesteatoma is an exaggeration of the normal desquamation constantly proceeding from all epithelial surfaces. The mucous membrane of the middle ear having at first become somewhat epidermized, the dead epithelial cells which should be cast off are retained in their place by the presence of retained secretion or by some other form of obstruction; eccentric pressure is thus gradually exerted by this inert and constantly increasing mass, which in course of time obliterates the papillæ normally found in the rete, and reduces the whole epidermized mucous surface to a membrane of extreme tenuity, and one having a perverted function. This pathological process invariably commences in the upper part of the tympanic cavity—that is to say, in the attic—but it may extend over the whole of the internal wall of the tympanum, and will persist after the removal of all obstruction; the extension may proceed to such an extent that it involves, besides the attic, the whole of the antrum, and may penetrate one of the fossæ of the skull, as well as hollow out the whole of the mastoid process, or even the inner ear and petrous portion itself; the bones are absorbed in consequence of the pressure as an effect of the process. The cholesteatomatous formation does not invade osseous tissue after the manner of a malignant growth.

Cholesteatoma almost invariably occurs as the result of chronic suppuration in the middle ear, though some observers maintain that it may be primary. Cases certainly do exist in which a small cholesteatomatous mass is observed beneath an intact membrana tympani, but usually a history of former suppuration can be obtained, and a belief in original cholesteatomatous formation without previous

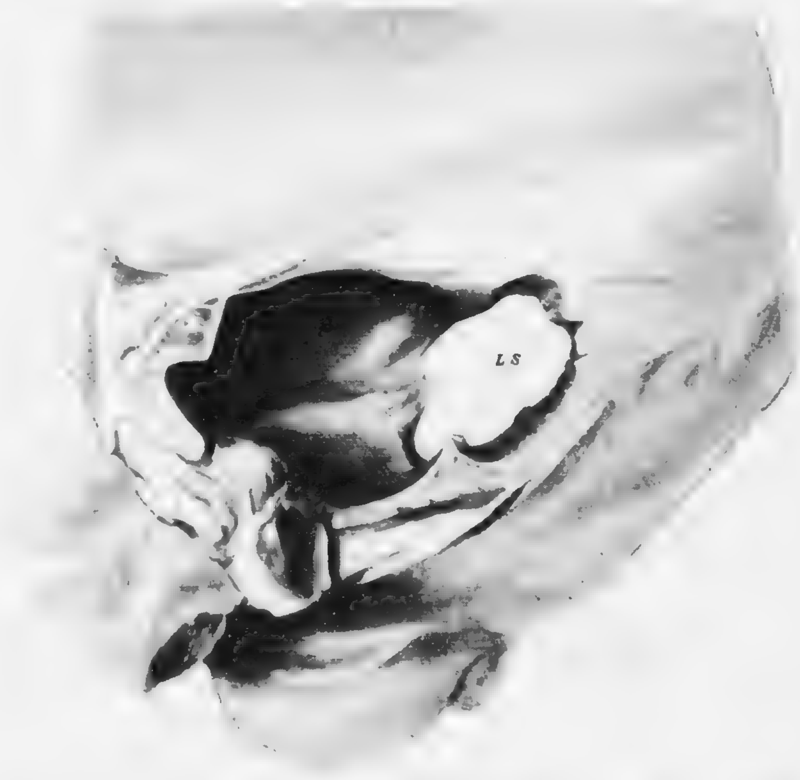

FIG. 49.—VERY EXTENSIVE CHOLESTEATOMA OF EAR, CAUSING COMPLETE ABSORPTION OF INTERNAL EAR, OPENING UP LATERAL SINUS (*L.S.*), AND CAUSING DEATH BY PYÆMIA.

or existing suppuration in the middle ear is not by any means universally held. Under the microscope the tumour consists of laminated layers of epithelium, amongst which cholesterin crystals are to be found.

The objective appearances of this condition consist, in the severer cases, of a yellowish adherent mass within the tympanum, extending at times to the deeper parts of the external meatus; the material, when removed by the syringe or forceps, is found to consist of dead epithelium, more or less discoloured, the lower layers being extremely adherent to the underlying tissues, though in some cases all except the most recently-formed layer come away very easily. In the less advanced cases the inner wall of the tympanum, instead of being of a pink or yellowish colour, is white and rough, and attempts to remove this adherent material cause pain, and are often attended by slight bleeding.

Treatment.—The essential to be aimed at in the cure of this condition being to obtain absolute dryness, it became necessary to consider carefully whether treatment with alcohol is calculated to obtain such a result. The reasons which militate against this form of treatment are, that in the first place, alcohol rarely of itself, however carefully applied, obtains a cure; and the second is that alcohol evaporates less readily than it absorbs water, and that unless the alcohol be absolutely absolute, or as nearly so as can be commercially obtained, it contains already a certain amount of water, which must be left behind, were it possible that the alcohol were entirely evaporated. It seemed necessary, therefore, to seek further. The only fluid which apparently fulfilled the requirement was ether, and after some years of trial ether has in my hands apparently acted in the way in which it was hoped it would. Ether, like alcohol, causes a certain amount of local discomfort, but the burning and pain are less in intensity and more evanescent. The method of applying ether is to take a probe armed with cotton-wool saturated with ether, and to well swab out the disease-area. When this is done by the medical man himself, very rapid drying can be obtained by gently blowing into the ear with a rubber bag

(Politzer's). The patients themselves can easily carry out this treatment, but they should be seen at intervals for the surgeon to remove any dry fragments of the mass which have not come away on the swabs. If the disease is extensive, and there is reason to suspect that the antrum is involved, it will be necessary that this cavity should be opened in order to treat the morbid changes effectively, and without unnecessary delay. In cases which present smaller areas of disease, all the flakes of tissue should be removed by means of the curette or syringe; under which circumstances an antiseptic solution should be invariably used for irrigation. It is often necessary to use solvents to loosen and dissolve the epithelium for some time before it is possible to clear away completely all the dead and diseased tissue. Unless the patient is under close observation there is a theoretical objection to the use of aqueous solutions in the treatment of this disease, whether in attempting to remove the mass or to soften it, and a case is on record in which a fatal result is said to have followed. The reason of this is said to be that the cholesteatomatous mass imbibes water freely, and in consequence swells. Since the mass contains a large number of micro-organisms, they are thus forced into the surrounding tissues, and septic

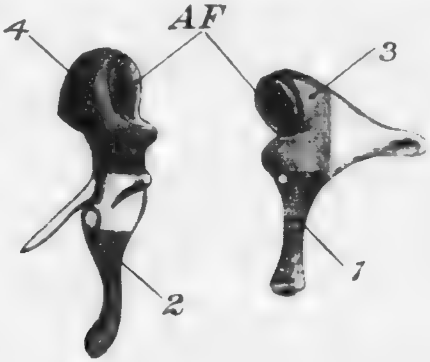

FIG. 50.—DIAGRAM SHOWING THE TWO LARGER OSSICLES SHADED TO SHOW THE MORE USUAL SITES OF CARIES.

1 and 2, The most common; 3 and 4, the next, the lightly shaded parts resisting the longest; *AF*, articular facets.

absorption follows. Of all the solvents papaine and salicylic acid are the most useful, and may be used either in solution or as a paste (see Appendix); whilst for the purpose of irrigation weak solutions of formalin or perchloride of mercury form the best fluids; the preliminary use of peroxide of hydrogen is often extremely valuable. This preparation, of the strength of 10 to 20 volumes, may also be used with great efficacy after a solvent has been used for a week or so. It will then bring away large quantities of material, or loosen them sufficiently to allow of their removal by syringe. The various pastes are employed in the form of pellets, which are pressed into any recesses affected, or so applied as to be in apposition with the cholesteatomatous matrix. The ear is cleansed after an interval, which varies from a half to one week, and a fresh application made.

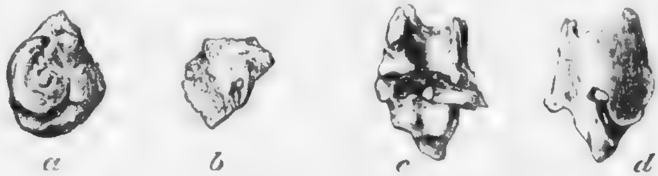

FIG. 51.—NECROSIS OF THE LABYRINTH.

a, Cochlea; *b*, one semicircular canal; *c* and *d*, vestibule, internal auditory meatus, and semicircular canals, seen from both sides.

Necrosis of the Ossicles.—The significance of this condition is dealt with elsewhere. The following perforations of the membrane are those more usually associated with this complication: Perforation in Shrapnell's membrane, and in the posterior superior quadrant, and cases of complete or extensive destruction of the drum. In order to detect a necrosed ossicle, use is made of the end of a fine probe bent at an angle of 120°, the upturned portion being about $\frac{3}{16}$ inch in length. The most suitable probe for this examination is Hartmann's. This instrument is introduced through the perforation in the direction of the head of the malleus, and if necrosis is present a fine grating will be felt by the examiner and heard by the patient.

Necrosis of the Temporal Bone.—This complication is more frequent in children, and is of infinitely greater rarity than necrosis of the ossicles. Necrosed pieces of bone of any size, usually black on the surface, may partly or entirely occlude the external meatus. They are readily detected by the probe, and may consist of a portion of any part of the temporal bone, and vary in size from thin flakes to large irregular masses; in a fair number of instances, and these commonly in adults, a sequestrum has been found of part or the whole of the osseous labyrinth.

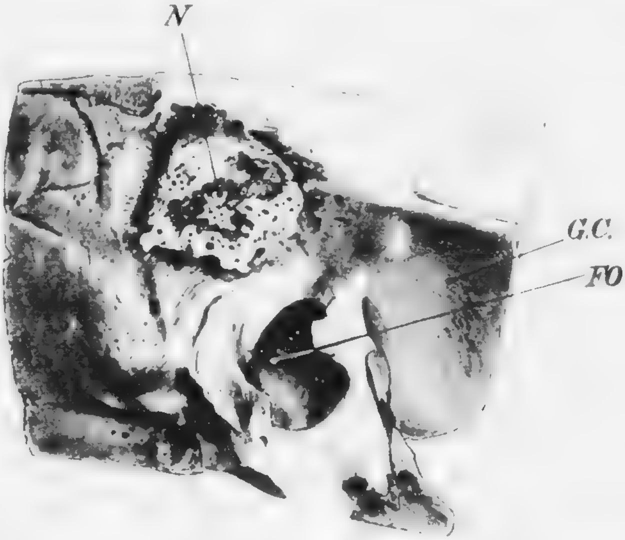

FIG. 52.—OUTER SURFACE OF TEMPORAL BONE OF A FOUR-YEAR-OLD CHILD, SHOWING NECROSIS OVER THE SITE OF MASTOID ANTRUM.

N, Area of necrosis, consisting of external antral wall; *GC*, glenoid cavity; *FO*, fenestra ovalis.

Necrosis of the temporal bone demands more prompt removal than does necrosed bone in most other parts of the body, and it is usually removed by means of the opening made for the radical mastoid operation. The operation is more imperative if the bone lies deeply and involves the petrous portion of the temporal bone, for the important relationship that the internal jugular vein and internal carotid artery bear to the labyrinth must be borne in mind. Formerly, it was advised to accomplish the removal of small flakes of dead bone by means of the instillation of dilute hydrochloric acid. This, however, is a tedious, unsatisfactory, and somewhat unsurgical procedure, and should not be resorted to unless under very exceptional circumstances.

The presence of necrosed bone in the middle ear or tympanic cavity, or elsewhere in this region, becomes immediately a proper indication for the performance of the radical operation. These sequestra should not be removed through the external meatus, as it is not possible to be sure that in extracting them through the meatus some large and important structure may not be injured, as, for instance, the bulb of the jugular vein. The radical operation is the proper surgical procedure.

External and Internal Fistulæ.—External fistulæ are usually found close behind the auricle, and lead down to the cavity of a chronic abscess in the mastoid. Fistulæ in the external auditory meatus are found in the roof and posterior wall. Both these varieties of fistulæ are due to the rupture and subsequent discharge of an abscess situated within the mastoid, and although fistulæ are not of themselves directly dangerous to life, yet they should always be attended to, as the cavities may become infected with chronic tuberculous disease, and result in extensive areas of disease. When in the roof of the meatus they lead into those cells which have been described as the 'border cells,' lying external to the attic; whilst fistulæ in the posterior wall lead either directly into the antrum or into one of the large cells in the mastoid.

The treatment of these cases, with the exception of sinuses in the roof of the external meatus, is the radical operation. When the sinus is in the roof, with an intact membrana tympani and good hearing, a cure may at times be obtained by an energetic use of the curette without external operation, or the performance of an incomplete mastoid operation; the removal of the disease without opening the antrum may result in complete healing.

Contraction of the Meatus.—Whether this be membranous

—that is to say, cicatricial—or whether it be due to bony outgrowth—exostosis or hyperostosis—it becomes imperative that a radical operation should be done within a reasonable time, especially if there be a discharge which is at all hindered in its escape by the contracted condition. Membranous stenosis of the external meatus is brought about by an inflammatory exudation within its wall, which, when converted into fibrous tissue, results in a circular contraction of the canal. Hyperostosis, or a bony outgrowth, may be due to the irritation of the discharge, or it may be coincidence.

Facial Paralysis.—Facial paralysis, or Bell's palsy, is a complication which may occur either in acute or chronic disease of the middle ear. So long ago as 1872 Sir William Dalby pointed out that those cases of facial paralysis said to have followed exposure to a draught were frequently due to an acute median otitis, the pain of which was so slight and evanescent as to have been quite overlooked both by patient and physician.

In acute suppuration of the middle ear, especially in children, paralysis of the face on the same side may supervene, which will get quite well after the otorrhœa has been cured, though perhaps not immediately; in a large number of cases the use of the galvanic current will be necessary. The nerve, in those cases of paralysis which complicate acute disease of the middle ear, is compressed within the bony tube by inflammatory products, due to an extension of inflammation from the mucous membrane lining the tympanum to the neurilemma and to the periosteal lining of the Fallopian canal, by means of a perforation frequently found in the wall of the canal just at the point where the nerve passes above the fenestra ovalis

A facial paralysis in chronic suppurative disease of the middle ear is a thing of vastly different import, and has a much more serious significance. It invariably indicates disease of some part of the temporal bone, and not infrequently necrosis of the labyrinth; the paralysis is an indication for the performance without delay of the radical mastoid operation, and in cases of tuberculous disease signifies an extension of the malady. It may occur as a central lesion, or at any rate as a lesion not due to any interference of the nerves in their passage through the temporal bone. In such cases there will be other indications to guide the surgeon to a correct estimate of its significance.

Erosion of the Internal Carotid Artery.

This rare complication is usually due to destructive ulceration arising in the course of chronic suppurative middle-ear disease. It has, however, occasionally been reported as having occurred in children in whom there has been no previous intimation of any disease of the ear, although it is impossible to avoid the suspicion that it was due to the before-mentioned cause. In such a case the patient will have a sudden hæmorrhage from the nose, mouth, and ear, which may be immediately fatal, or may prove so by a recurrence of the hæmorrhage even before assistance can be obtained. Post-mortem examination shows that the ulcerative process has in its course eroded the arterial wall.

TREATMENT.—The treatment must be directed primarily to stopping the hæmorrhage, and secondarily to the prevention of its recurrence. If the hæmorrhage is very severe and is not controlled by pressure on the internal carotid artery, the best line of treatment consists in the ligation of the common carotid artery and the performance of the radical mastoid operation. All carious bone is to be removed, and the cavity thoroughly cleansed with a very strong antiseptic, as advised on p. 210; a plug of sterilized beeswax is used to seal up and compress the artery in its bony canal, if the vessel can be reached.

Hæmorrhage from the Jugular Bulb.

When hæmorrhage occurs in this situation, it may be from an ulcerative process eroding the external wall of the bulb in a similar manner to that which has just been alluded to in the case of the internal carotid, or it may be due to the long wall of the vessel being punctured during incision of the membrana tympani. In rare instances the bony protection afforded to this portion of the jugular is absent, and the vein lies just behind the mucous membrane of the posterior and inferior part of the inner wall of the tympanum. In such instances the surgeon might notice a pulsatory movement conveyed to the membrana tympani, or even visible through it, and probably also a bluish reflex in the posterior inferior quadrant of the membrane. From whichever cause the hæmorrhage arises, careful and deep plugging under proper antiseptic precautions will allow healing to take place in the wall of the vessel. Should the hæmorrhage be due to ulceration, antiseptic irrigation, even while hæmorrhage is taking place, should be employed. Here, as in the former case, rest in the recumbent position and absolute quiet are to be enjoined on the patient. In the event of failure of these measures, the sinus should be exposed and compressed with a plug, as described before, and it may even be necessary also to ligate the internal jugular vein.

Intralabyrinthine Suppuration.—See p. 259.

Abnormal Conditions occurring as Sequelæ to Chronic Suppuration in the Middle Ear.

In the meatus, besides those conditions already described, various contractions may be found. These may take the form either of a diaphragm entirely occluding the meatus, or of a cicatricial contraction with a central perforation. In the former instance suppuration will have ceased; consequently behind this web it is rare to find retained secretion. If, however, there is a hole in the centre of the web, more frequently than not suppuration is still going on, and pus is exuded more or less copiously through the opening. If the web be complete and deafness result, a crucial incision should be made, the knife cutting right down to the bone, or a circular incision made to remove the whole of the obstruction. A metal tube should be afterwards introduced into the meatus large enough to fit fairly tightly; this dilator must be retained in the ear for about a month or six weeks, the passage irrigated two or three times a day with antiseptic lotion, and the tube taken out at first once a day and cleansed and replaced. The wound heals in the course of a week or ten days, but it is necessary to keep the tube in the meatus for the time mentioned, in order to overcome the tendency of a second membranous web to form through cicatricial contraction. If, however, there is still discharge, showing the presence of suppuration in the middle ear, it is wiser immediately to perform a radical operation than to attempt to dilate the stricture, as this is a tedious process, and not—theoretically, at all events—devoid of risk. During the process of dilatation, if laminaria tents are used, as is commonly advised, the pus is retained as long as the tent is in position, and septic absorption is encouraged. Unless the disease in the middle ear is entirely cured, contraction will occur again, and the patient within a short time will be in the same state as if no treatment had been adopted

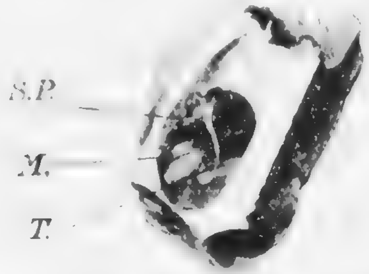

FIG. 53.—PREPARATION SHOWING THE HANDLE OF THE MALLEUS BOUND DOWN BY CICATRICIAL TISSUE AFTER CESSATION OF CHRONIC SUPPURATION.

SP, Short process; *M*, cicatricial membrane; *T*, tip of malleolar handle adherent to promontory.

The membrana tympani itself may exhibit many post-suppurative changes. If the original perforation were extensive and have become entirely filled in, this scar membrane will be thinner than the normal, will contain far less fibrous tissue, and at the same time this fibrous tissue will not have the necessary resilience nor proper arrangement of its fibres; it will thus be easily influenced by changes in pressure either from without or within, and in consequence it often becomes extremely retracted, even to the extent of lying closely applied to the inner wall of the tympanum.

In the reverse condition of this, after suppuration has ceased, a large part of the membrane is found to have undergone calcareous degeneration; this is not to be attributed always to the effect of suppuration, but partly to coincidence, as this chalky change is found with equal frequency in patients, some very young, who have never suffered from suppuration.

At other times the membrane does not exhibit signs of healing, and the perforation persists, the edges of which are usually thickened and rounded, having much the appearance in miniature of the edges of a chronic ulcer of the leg. This variety has been termed a residual perforation, and it is possible at times to obtain its healing by means of the irritation of its edges. This mode of treatment is only advisable if the perforation be small, and if a pledget of wool making good the gap improve the hearing. The slight operation should be done under mild, though careful, antiseptic precautions. If the antiseptics used are too strong, the moderate degree of inflammation which is necessary for the healing process will be checked. There are two agents which have been found useful in such cases, namely, chromic and trichloracetic acids. If the former be chosen, it must be used on the tip of a fine probe; a few crystals of the acid are picked up by the probe, which is then heated in a spirit flame an inch from its tip. The crystals melt, and the end is uniformly coated with the acid by the simple plan of rotating the probe. After the canal has been syringed with boracic lotion and dried, the prepared probe is carefully applied to the edge of the perforation. Caution must be exercised to avoid the acid running and so cauterizing other parts. With trichloracetic acid it is better to take the deliquesced acid on a small cotton-wool mop, and apply it in the same way. A little iodoform may then be insufflated, and the meatus lightly packed with an antiseptic wool or gauze. At the end of a day or two the edge of the perforation should be pink, and begin to show a tendency to close; it is, however, generally necessary to stimulate the edges from time to time.

In other instances the edge of the perforation in the membrane has become adherent to the inner wall of the tympanum, whilst in others the ossicles are bound down to adjacent structures by means of cicatricial bands.

The treatment of these cases depends on the amount of deafness experienced, and on the amount of improvement derived from artificial membranes. If the deafness is troublesome and no material relief is obtained by the use of the so-called artificial drum, then minor operations should be tried

Of these operations there is one which is a fairly recognized procedure—viz., the so-called circumcision of the stapes; it may be tried in cases where the stapes is firmly tied down into the niche of the fenestra ovalis by means of cicatricial tissue.

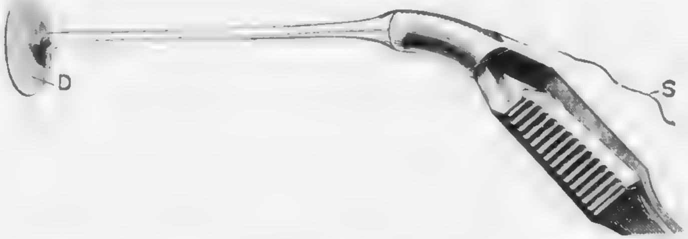

FIG. 54.—CARRIER FOR INTRODUCING ARTIFICIAL TYMPANIC MEMBRANES.

D, rubber disc; *S*, thread attached to disc.

After cocaine or eucaine, or Gray's solution, has been applied and the part rendered insensitive, a spud-shaped knife or a sharp-pointed myringotome is used to divide the scar tissue by parallel lines down almost to the bottom of the fenestra ovalis. Material improvement of hearing will frequently follow, but the result does not usually last for more than a few weeks, when the treatment must be repeated, the surgeon endeavouring to follow in the lines of the original incisions, and in a fair proportion of cases a degree of lasting improvement is obtained

A modification of this line of treatment consists in applying a minute quantity of chromic acid into the fresh incisions, so as to cause a sloughing of the cicatricial tissue, and thus prevent the necessity of more than one operation. This method has a slight disadvantage, inasmuch as the Fallopian canal is sometimes deficient in this region, and the swelling set up may cause temporary facial paralysis. Other divisions of cicatricial tissue must necessarily depend upon the situation of the bands, and at times it is justifiable to perform a complete ossiculectomy with the hope of improving the condition of deafness.

When the perforation is in the upper part of the membrane, and the edge of the meatus somewhat destroyed by the suppurative process, especially if the attic is involved, a condition almost approaching cholesteatomatous formation is observed —that is to say, adherent flakes of skin are found which have formed in this situation, and are not thrown off. They can be easily removed by the aid of fine forceps after having been loosened by the use of a probe ; their removal will frequently very considerably improve the comfort of the patient, and also perhaps his hearing-power.

CHAPTER XI

INTRACRANIAL COMPLICATIONS

Pathways of Infection in Otitic Intracranial Disease.

INFECTION may be conveyed from septic conditions in the middle or internal ear and adjacent parts of the mastoid bone to the meninges, cerebrum, and cerebellum by the following routes: From the middle ear through an erosion of the bony covering or a natural dehiscence of the bony covering of the carotid canal, thereby enabling pus to find its way alongside of the artery; through erosion or absence of the tegmen tympani; by the passage of pus through an occasional series of cells running through the petrous portion of the temporal bone, opening on the one hand into the cavum tympani above the orifice of the Eustachian tube, and on the other into the middle fossa of the skull, close to the Gasserian ganglion; very rarely indeed by the facial canal; from the antrum, by either caries or necrosis of its walls; from the labyrinth, through the internal auditory meatus, through perforation of the superior semicircular canal, and by the aquæductus vestibuli. These may be taken to represent the principal tracts by which infection is carried within the cranial vault, and which act as the pathways by which infection in meningitis, extradural abscess, cranial and cerebellar abscess is conveyed.

Meningitis. Infection of the meninges of the brain may occur in the course of otitis media suppurativa, either in acute cases, with perforation of the tympanic membrane; as a sequel to acute mastoiditis, without perforation of the drum; or in chronic suppuration of the middle ear. Meningitis may coexist with any of the other septic intracranial complications.

SYMPTOMS.—The patients complains of feverishness and cephalalgia, ushered in at times by a slight rigor, with vomiting, and he has at this time a quick and full pulse. With the progress of the disease the cephalalgia becomes more intense, and, in common with the other otitic intracranial complications, becomes so severe that the patient cries out with pain. Intolerance of light, at times amounting to photophobia, with hyperæsthesia acustica, together with marked retraction of the head in basic infection, become marked. The pupils, which are commonly unequal, react to light, but usually more or less slowly than normal. Optic neuritis, or papillitis, will in most cases be noted. The patient now tends gradually towards a lethargic state of mind and body. The pupils become widely, though often unequally, dilated, and all reaction to light gradually is lost ; whilst in basic cases a tendency to squinting is more frequently noted than in other varieties. A partial paralysis, or hemiplegic condition, may set in at this stage of the disease, but eventually total paralysis, with stertor and profound insensibility, will occur if the effusion is great. The pulse-rate during the latter part of the illness is rapid and irregular ; the respirations are also irregular, though slow. Nystagmus may be present in the later stages of the disease.

TREATMENT.—When the patient is seen at the commencement of the affection, immediate operation offers the best hope of saving life. The meninges are freely exposed either by an extension of the radical mastoid operation or by the removal of a large piece of the parietal bone and incised, the immediate area of disease bathed with boracic lotion and dressed with antiseptics. A culture from the infected area should be taken, and a vaccine made and injected, or if this proves the presence of streptococci, the effect of the antitoxin may be tried. Lumbar puncture as a means of diagnosis is of extreme value (for the differential diagnosis, see p. 195). The most hope from drugs comes from a careful and judicious use of mercury and bark, combined with opium for the relief of pain, or large doses of calomel and quinine ; ice-bags to the head should be employed, and the patient kept strictly quiet in a darkened room. Lumbar puncture is also recommended as a means of treatment.

The depression and drainage operation of Haynes deserves consideration. The patient lies face downwards, and after the necessary preparations an incision is made downwards in the mid-line from the occipital protuberance to the spinous process of the axis. After exposing the skull, a disc of bone is removed about 1 inch above the foramen magnum. This opening is enlarged downwards, so as to connect the trephine opening and the foramen magnum. The next step is to incise the dura vertically in the mid-line, behaving according as the presence or absence of an occipital sinus demands. The subarachnoid space is entered either by the original cut through the dura or by extending the dural incision. Too rapid evacuation of the subarachnoid fluid must be checked, the state of the blood-pressure being the most reliable guide. If there is reason to suspect plugging of the foramen of Magendie, the posterior poles of the cerebellum are gently pushed up and apart. Drainage is obtained by means of a sheet of thin rubber folded up, and about ¼ inch wide.

Extradural Abscess.—For routes of infection, see *ante*. The abscess is either situated external to the dura of the middle fossa, or, when the infection proceeds through the antrum and the posterior cells connected with it, in the sigmoid groove between the bone and the lateral sinus. The extradural collection of pus found in the middle fossa is almost invariably the product of chronic suppuration ; whereas the abscess situated in the sigmoid sinus may be found as a result either of acute or chronic suppuration.

SYMPTOMS.—The only constant symptom in extradural abscess is cephalalgia. This is often so intense that the patient rolls in agony or cries out with pain, and is unable to sleep at night. This severity of suffering is more especially the case when the abscess is the result of chronic suppuration of the middle ear. Percussion over the squamous portion of the temporal bone or deep pressure will usually locate a small painful area, at which point the pain is most noticeable, and from which it radiates. The pain is of a neuralgic character, spreading upwards over the side of the head. The temperature in acute cases is high, but in chronic often slightly raised above the normal. The pulse may be either unnaturally slow, normal, or slightly accelerated, and, if the extradural abscess is uncomplicated, it is rare to find optic papillitis. Thus reliance has largely to be placed upon the history of the case, which may be that of an old-standing suppuration from the ear, with gradually increasing cephalalgia; at the commencement the pain is little more than a severe headache, but, as noted before, it may become sufficiently severe to prevent sleep and cause the greatest distress to the patient. If the abscess becomes of large size, there may be symptoms of cortical irritation, as evinced by spasms of the muscles of the limbs on the opposite side of the body, and in rare cases the patient may become comatose. The acute cases are those following influenza, and will occur when the mastoid consists entirely of cells. In such cases the pain will have been severe, and the whole mastoid process tender on pressure. If this condition is not recognized and suitably treated by operation, either lateral sinus pyæmia or septic meningitis will ensue.

TREATMENT.—Operation alone affords relief to the patient. In this, the mildest of all the intracranial complications due to suppuration in the middle ear, treatment varies with the acuteness or chronicity of the attack. In acute cases the mastoid antrum should be first opened; it is always advisable to work from the antrum towards the abscess, following up the track by which the infection proceeded. In chronic cases an examination should be made in every instance both of the middle fossa and the sigmoid groove. Should the dura mater or the lateral sinus appear unhealthy when exposed, further examination of these parts should be made as described under the separate diseases. Having evacuated the abscess, the cavity should be cleansed with a strong antiseptic solution, such as Lister's strong fluid, and the wound, having been well dusted with iodoform, is lightly plugged from the bottom. In chronic cases where the radical mastoid operation has been performed, the end of the plug may be drawn through the external meatus ; but even in these cases it is better not to close the wound entirely. In acute cases, where the radical operation has not been performed, the wound is not entirely closed, and the end of the gauze strip is brought out into the lower part. The evacuation of the pus is followed by an incision of the tympanic membrane, for this measure is usually necessary. The whole of the canal is now carefully irrigated, and the external meatus plugged from the bottom.

Otitic Cerebral Abscess.—Cerebral abscess occurs in the majority of instances as a sequel to, or complication of, chronic purulent otitis media. Acute suppurative otitis media is occasionally the source of infection. Cerebral abscess has been known to follow an attack of acute otitis media in which no perforation of the tympanic membrane has been observed, but in which abscess or inflammation of the mastoid antrum or one of its cells has occurred. (For modes of infection, see *ante.*)

The following description of a cerebral abscess situated in the temporo-sphenoidal lobe may be considered as typical, but it must be borne in mind that one, or even most, of the more characteristic signs may be—indeed, often are—absent. Also, when the patient is first seen, either in the late secondary or third stage, it is chiefly by a process of deduction and of exclusion that it is possible to arrive at a correct diagnosis.

Abscess of the brain may be divided clinically into three stages. In the first stage the patient is, in the majority of instances, a sufferer from chronic otitis media ; he becomes suddenly ill, and a history of a recent chill or injury to the head may not infrequently be obtained. In this, the earliest stage, the symptoms are chiefly referred to the ear. Pain is the prominent symptom, and is of a hot, burning, or shooting character, spreading, after a short interval, over the temporal region, where it often becomes chiefly located, and then apt to become most violent in character, even causing the most intense agony. It may be either persistent or intermittent, but often so severe that the patient is almost unable to bear it. Vomiting, not referable to the ingestion of food, is likely to occur at this stage, and either before or at the same time as the onset of vomiting a slight rigor is usually noticed, with a moderate rise of temperature. This probably does not exceed 103° F., and in uncomplicated cases the rigor is rarely repeated. The general state of the temperature during the first stage is only slightly above normal, whilst the pulse is quickened and the tongue becomes furred. The patient is obviously very ill, and at the time that the rigor occurs the discharge from the ear, in the great majority of instances, is lessened in quantity or ceases entirely. This stage is of variable duration, and may exist for a few hours or several days. It is, however, rarely that the patient is brought under observation at this time, as not infrequently he has suffered and recovered previously from a condition very similar, though of a less severe type, which was probably due to septic poisoning from absorption of the products of suppuration.

The second stage is that in which the patient is commonly seen. By this time the pain has become considerably mitigated, and the state of the patient tends more towards a dull and quiet state of mind and body, so that he is apt to lie quietly dozing, except during attacks of pain. Pain at this time is not loudly complained of, but may be elicited by percussion over the temporal bone, and the head may be tender on pressure over the same area. Cerebration is delayed, and though at the beginning of the second stage questions will be answered correctly, but after a distinct interval, yet, as the abscess increases in size or as the symptoms become intensified, a distinct loss of memory will often be observed, this loss being first noticed in the inability on the part of the patient to remember the names of places with which he is perfectly familiar. He will be unable to state where he lives or to give the correct names of common articles, and there is little evidence of spontaneous cerebration. The inclination to sleep becomes greater and at the same time the sleep is troubled, restless, and broken. The temperature varies in this stage from 97° to 99° F., being more frequently slightly below than above normal. The pulse-rate sinks gradually to a rate varying from 30 to 60 per minute, and together with the sinking of the pulse-rate a diminution in the number of respirations per minute will be noted, these not infrequently falling as low as 11 or 12, though in cerebral abscess this slowness of respiration does not equal that observed in cases of cerebellar abscess. The bowels are usually obstinately constipated, and there is a loss of control over the bladder, which is evinced either by retention or incontinence of urine, and albumin is usually present in small quantities. Vomiting and giddiness are present when the patient is able to move about. Paralysis, when it occurs, aids materially in localizing the site of the abscess. Thus paralysis, when observed on the side of the body opposite to the seat of the lesion, may be either of the cortical or internal capsular variety. In the former instance the paralysis occurs in the following order: First, the facial muscles, then those of the arm, and, lastly, those of the leg; but the latter are only slightly affected and sensation is preserved; while in paralysis due to pressure on the internal capsule the order is inverted, being leg, arm, then face, together with loss of sensation. When the facial nerve is paralyzed from the presence of an abscess of the brain the loss of power is not so complete as that which occurs from a lesion to the nerve in the Fallopian canal. The state of the pupil on the affected side varies. It is frequently contracted, and only reacts sluggishly to light and accommodation, in which case the abscess will be relatively small. But if the abscess is of large size, the pupil on the same side will be both dilated and stable. Paralysis of the third nerve on the same side as the abscess is a variable sign; that of the sixth is less common. Optic neuritis, or papillitis, is found during the whole of this stage, and may be only on the affected side. The tongue becomes furred, and towards the end of the second stage sordes are frequently present on the lips and teeth, while a strong putrid odour emanates from the patient's breath, and where consciousness is preserved a subjective bad odour may be complained of.

The possible terminations of cerebral abscess after the end of the second stage are either spontaneous evacuation, or, when the disease is untreated, the patient passes into the third and final stage. Spontaneous evacuation occasionally occurs by discharge of the abscess through the external meatus, the pus having found its way through the cerebral tissues, and through a lesion in both the dura mater and tegmen tympani. This is a rare result, but one which has been reported from time to time.

In the third stage proper the patient lies in a deep comatose condition, in which Cheyne-Stokes respiration is common. This condition after the lapse of a short period terminates in death.

TREATMENT.—The treatment in the first stage will consist in a preliminary radical operation on the mastoid, with an exploration of the base of the middle fossa, by cutting away the tegmen tympani. As at this stage there is no formation of pus in the brain, no indication may be found to proceed further. Such an indication would be a non-pulsatory bulging of the dura mater.

In the second stage, although a radical mastoid operation must be performed in order to remove the primary focus of disease, the condition of the patient must guide the surgeon as to the desirability of performing this operation at the time at which the abscess is evacuated. Should the radical operation have been performed, the bone may be removed until the same region has been exposed as would have been exposed by the trephine being applied over a spot 1¼ inches behind and 1¼ inches above the centre of the external meatus. On exposure, the dura mater is incised and the brain explored either by means of the blade of a bistoury, Horsley's cerebral pus-searcher, or a large trocar and cannula. Should this measure fail in locating the abscess, the sterilized finger is, after incision of the brain substance, introduced gently into the cerebral tissue, and the abscess may be detected by a sensation of resistance and then evacuated. After pus has been found, the instrument should on no account be withdrawn unless a director is left with its point well within the abscess cavity. A double drainage-tube, as large a size as possible, should be passed into the abscess cavity, which is then irrigated with boracic solution. These tubes should be secured by sutures and the wound dressed. After the evacuation of pus, the pulse will become accelerated, respiration will again become normal, whilst the temperature will rise, to fall, if the case progresses favourably, within a few hours. As soon as the pus has ceased discharging from the abscess walls the tubes should be shortened and eventually removed, and the scalp wound closed by freshening and suturing its edges.

Intradural Abscess is almost exclusively found in the posterior fossa, and is situated in close juxtaposition to the posterior surface of the petrous bone, its origin being direct infection from a septic labyrinthine lesion, or direct infection through the mastoid cells lying posterior and slightly internal to the antrum. The symptoms are vague, chiefly those of compression of the brain. Localizing symptoms are absent, but local pain is common. The temperature is rarely much elevated. A blood-count will probably point to the presence of pus. The patient's condition varies from slight cephalalgia only to cephalalgia with marked tenderness of the region to percussion. It is to be remembered that these abscesses are often associated with cerebellar abscess.

TREATMENT.—After a radical mastoid operation has been performed, and the labyrinthine suppuration looked for, the posterior wall of the operation cavity is carried back internally to the sinus, the opening being made as large as possible. The pus can be evacuated through this opening. After its complete removal the cavity is to be thoroughly cleansed, filled with iodoform emulsion, and packed with gauze, the rest of the operation cavity being treated as before laid down. The wound must be only partially closed to permit of subsequent dressings.

Cerebellar Abscess is rarely acute, but may run an entirely latent course, and on account of the difficulty of distinguishing intradural abscesses from true cerebellar in the reports of cases, exact tabulation of symptoms is difficult.

In cerebellar abscess nystagmus is always present, and herein lies one of the principal diagnostic difficulties. In labyrinthine disease the nystagmus, when elicited, is, if the labyrinth is generally infected, towards the sound side; when the destruction of the organ is complete, after a brief interval of increased intensity, it ceases. Cerebellar nystagmus may be to either side. If, however, nystagmus towards the diseased side, the nystagmus is probably cerebellar; if towards the sound side, it is either cerebellar or a localized labyrinthine affection. With a non-irritable labyrinth the presence of nystagmus points to cerebellar abscess; but when the nystagmus is towards the sound side, with a non-irritable labyrinth, no certainty exists, and it has been advised that the labyrinth be ablated and the effect noted, but this seems a most questionable procedure. Careful observation of the patient is better, and a blood-count may assist in clearing up the diagnosis.

The temperature is not usually raised, cerebration is slow, and a desire for sleep often present. Bradycardia is frequent, and the pulse-rate is not often in keeping with the temperature. Cephalalgia, often localized, is a common symptom, though it may be frontal. Stiffness and pain on pressure on the muscles at the back of the neck is also a valuable sign. Vomiting unassociated with the ingestion of food, optic papillitis and choked discs, are both common, the first especially so. Squint is sometimes found.

Cerebellar ataxy is most marked when the patient walks with closed eyes. Jumping and hopping, although able to show this better, should not be put in practice, as the jarring may be very deleterious. The position of the head affects the gait. Weakness of the hand-grip on the affected side, and of the leg on the same side, together with increased knee-jerk, may be found. The attitude of the patient in bed is characteristic of the effect of cerebral irritation—that is to say, he tends to lie coiled up, with body and limbs flexed, and looking away from the affected side.

TREATMENT.—The mastoid should be examined either at the same time as the abscess is sought for or later. With the special object of exploring the cerebellum, a curved incision, with the convexity upwards and commencing close behind the pinna, is carried backwards and downwards to about 1½ to 2 inches behind the mastoid process right down to the bone; the occipital artery is usually divided, and all the tissues, including some of the sterno-mastoid muscle, reflected so that a trephine can be applied to the skull in such a way that it lies against the posterior border of the mastoid process, with its upper edge below Reid's base line. After the disc of bone has been removed and the dura mater opened, the instrument used as a pus-searcher should be pushed firstly forwards, upwards, and inwards towards the surface of the petrous bone. If pus is not found in this direction, and as it may lie more than 2 inches from the surface, the finger should be introduced and the cerebellum explored, especially towards the tentorium, where the abscess may be situated between the upper surface of the cerebellum and this structure. When the abscess is found and evacuated, the same line of conduct must be observed as was recommended in dealing with cerebral abscess; but it is well to remember that a second cerebellar abscess is occasionally present, so that, if the symptoms are not relieved after evacuation of the first, further exploration should be immediately undertaken.

Thrombosis of the Lateral Sinus and Lateral Sinus Pyæmia.

Infection of this sinus occurs as a result of the extension of inflammatory disease from the middle ear or the adjacent structures.

The thrombus may or may not be septic; when, however, it has become infected by pathogenic organisms, general septic infection will occur.

The infection may be primary, by the direct extension of septic mischief through the mastoid antrum, and the cells between it and the lateral sinus in the sigmoid groove, thereby setting up a periphlebitis, with a subsequent formation of clot in the cavity of the sinus. Or a secondary thrombosis of this sinus will follow extension of clot from the cavernous, inferior petrosal, or superior petrosal sinus, internal auditory vein, the small vessels draining the tympanic cavity or the cochlear vein, the two last-mentioned vessels entering directly into the bulb of the lateral sinus direct.

Thrombosis of the lateral sinus itself, so long as the thrombosis is not septic, will be attended by no marked symptoms beyond those of slight pain and slight elevation of temperature. This absence of special symptoms is largely due to the fact that the thrombosis is almost always accompanied by some other pathological state, as extradural abscess or inflammation of the mastoid, which mask symptoms that would otherwise make themselves obvious. When the clot has become infected by pathogenic organisms penetrating its substance, the symptoms will develop rapidly from the moment that any septic matter finds its way into the blood-stream, however minute the amount of this poison may be. Thus the symptoms of lateral sinus disease will be, in its short preliminary stage, those of general illness, with an elevation of temperature and pain in the head, extending perhaps down the side of the neck. These symptoms will, if followed by a rigor, be attended by a rise of temperature rarely less than 104·5° F., though it may not exceed 103·5° F.; the latter degree is usually the highest temperature accompanying a rigor due to the formation of a brain abscess. At this time the discharge from the ear will be lessened, or will even temporarily cease, on account of the high temperature causing general diminution of all secretion. As the clot in the sinus increases in length and travels downwards, the patient, who already suffers from cephalalgia, will now complain of pain and stiffness in the region of the sterno-mastoid muscle, and a careful palpation in the course of the carotid vessels will demonstrate pain and tenderness in this region. The existence of a hard cord-like mass passing down towards the sterno-clavicular joint has been detected. This is caused by the presence of clot in the internal jugular vein, or by a string of swollen lymphatic glands lying upon the vein. Œdema over the mastoid process is present in a certain number of cases, and is due to a thrombosis of the emissory vein of Santorini, which is frequently found in the neighbourhood. Vomiting will usually be a marked feature of the case.

In the preliminary stages constipation is the rule, but as the case progresses diarrhœa usually develops, often accompanied by severe abdominal disturbance, a fact which may tend to throw the practitioner off his guard, and cause him to suspect typhoid fever. The rose spots of typhoid, however, will never be noticed. Increase of headache especially if the pain extends towards the occiput, may be taken as an indication of the extension of the clot towards the torcular Herophili. The rigors will be repeated frequently, and are usually followed by profuse perspiration, and all the symptoms commonly found in the so-called typhoid condition become gradually manifest. The skin is dry; the pulse frequent, small, and thready; sordes form on the lips and teeth; the belly is retracted; the breath has a sweet but offensive odour; and colliquative diarrhœa is the rule. Infarcts will often occur in the lungs, which are ushered in by pain resembling that of pleurisy, and cause a troublesome cough. Lateral sinus pyæmia of this type may give rise to the suspicion that the patient is suffering from the hypostatic pneumonia of typhoid, but a careful examination will demonstrate that the disease is purely local; after a short period the expectoration of prune-juice sputum will show that the chest symptoms are due to a local septic pneumonia. Infarcts also occur in the various joints, especially the smaller ones, and in other parts of the body.

The main points of diagnosis between typhoid fever and lateral sinus pyæmia are the absence of the rose-coloured spots of typhoid in this disease, the absence of pain on the right iliac fossa, the characteristic temperature chart of pyæmia, which differs markedly from that of enteric, together with the history of discharge from the ear. Widal's reaction is negative in pyæmia.

Treatment.—Of all intracranial complications of suppurative otitis media, this is the one which needs the most prompt and efficient relief. As soon as the diagnosis is made that the patient is suffering from lateral sinus thrombosis, an operation should be immediately undertaken. It consists primarily in exposing the sinus in the sigmoid sulcus, which should be accomplished by continuing backwards the bony wound formed after having done a rapid radical operation on the mastoid antrum. As soon as the sinus is reached, it should be exposed for at least an inch, and the vessel carefully examined with the finger, and if it is felt hard and clotted, an incision is made in its wall, and the clot removed by curetting first in one direction and then in the other, until the blood flows with a free stream. This hæmorrhage is checked by the insertion of a strip of gauze, which is packed in tightly between the sinus wall and the skull. The infected channel must be carefully cleansed with antiseptics and the wound similarly dressed. If, however, the clot extends into the jugular vein, or if the operator is unable to obtain a free flow of blood from the cardiac end, the jugular vein must be exposed in the neck by means of a long incision down the anterior border of the sterno-mastoid muscle, and the vein ligatured, if possible, below the clot. The vein is then divided, the clot removed, and an attempt made to syringe through from the vein into the wound in the skull. If the operator is unable to accomplish so much, it may be better to dissect out the whole of the vein, including the jugular bulb, although this extension of the operation is an undertaking which is of considerable magnitude and difficulty. But before proceeding to add to the already long and severe operation, the probable effect on the patient must be decided upon ; therefore, unless his condition is sufficiently good, the operator will be wiser if he postpones this for the present and waits on events.

Lumbar Puncture.—The following points, taken from Purvis Stewart's 'Diagnosis of Nervous Diseases,' will be of assistance in clearing up doubtful points in diagnosis of intracranial complications :

The fluid is purulent or cloudy in meningitis.

In suppurative meningitis and brain abscess with local meningitis, one finds polynuclear leucocytosis, mostly polymorphs.

There is absence of carbohydrates in the fluid in meningitis.

In brain abscess without meningitis there is no leucocytosis.

In subacute or chronic meningitis one finds excess of small monomorphs and a few large ones.

CHAPTER XII

OPERATIONS

I. Minor Operations.

MINOR operative measures undertaken for the relief of deafness and tinnitus have one general principle—the division of the structures which interfere to prevent the normal mobility of the ossicular chain. Such examples are the division of the tendon of the tensor tympani, division of the posterior fold or ligament of the malleus, the division of the anterior ligament of the malleus and of the tendon of the stapedius, as well as the separation of adhesions. With the exception of those minor operations already described, obviously no definite instructions can be laid down for the division of adhesions. Every adhesion which appears to have a deleterious influence upon the hearing should be divided, more especially those attaching the drum to the long process of the incus, which must be carefully dissected off with a myringotome curved on the flat; the frequent use of inflation, besides rarefaction of air in the external meatus, is to be employed to prevent readhesion during healing. These small operations are more beneficial when undertaken for the relief of tinnitus than for the improvement of audition, and patients should not be led to expect much betterment of their hearing.

Paracentesis, or Incision of the Drum.— The external meatus must be irrigated with an antiseptic solution and carefully dried. If a general anaesthetic is used, the light may be carefully focussed on the ear before the patient is deeply unconscious, in order to avoid undue waste of time, and especially so if nitrous oxide is used. The only instrument required is a sharp-pointed myringotome. The drum is perforated posterior to the handle of the malleus, within a short distance of the posterior fold of the membrane. The inner tympanic wall should not be touched. The knife is then passed straight down from the superior posterior part of the drum to the inferior part of the membrane, dividing it in almost its whole length. After the incision the canal is to be cleansed from all pus and blood either by means of sterilized wool mops or by irrigation. The canal is then packed with aseptic or antiseptic gauze, the inner end of which should touch the wound in the drum, in order to drain out all fluids from the middle ear. The dressing requires changing as soon as the outer end becomes damp, or, in other cases, at the end of twenty-four hours.

Division of the Tendon of the Tensor Tympani.—This operation may be performed under cocaine anæsthesia, but it is preferable to use a general anæsthetic. If cocaine be chosen, the aniline preparations must be employed, and strict antiseptic precautions are to be observed. An incision is made behind the handle of the malleus, commencing at the level of the short process, and extending down half the length of the handle. A tenotome is now introduced, either above or below the tendon, which is severed by a sawing movement of the knife. After the tenotome is removed a curved probe should be inserted in order to ascertain that the division is complete. Healing of the wound in the tympanic membrane will take place under antiseptic precautions in a few days, at the end of which time inflation should be employed in order to obtain improvement in hearing. The handle of the malleus tends to resume its normal position after this operation. In those cases in which the malleus is extremely retracted it may be necessary to divide the tendon through an anterior incision, there not being sufficient space for a posterior one.

The hæmorrhage from this slight operation is rarely troublesome, and may be easily checked by plugging.

Division of the Posterior Fold of the Membrane.—This procedure should only be employed when the structure is prominent, and several cuts made transversely to the fold. The incision must be from below, and performed with a sharp-pointed tenotome.

Division of the Anterior Ligament of the Malleus.—A sharp-pointed myringotome is inserted just below and in front of the short process. The knife is then forced upwards with a sawing movement towards the notch of Rivini, when the ligament will be felt to divide beneath the knife.

Division of the Stapedius Tendon.—The field of operation must be exposed by cutting a flap in the membrana tympani, which will fold downwards. This may be done by inserting the knife behind the handle of the malleus on a level with its short process, dividing the membrane horizontally backwards to the periphery, and then turning and cutting downwards for nearly the same distance. The slight bleeding which ensues must be checked by gentle pressure. When the hæmorrhage has been controlled, and after the removal of any blood-clot which obscures the field of view, the tendon is seen passing horizontally backwards from the head of the stapes, like a fine white thread. It is divided, the parts thoroughly cleansed with antiseptics, and the wound gently plugged. The wound in the membrane will heal with great rapidity. The tendon of the stapedius is divided after suppurative otitis media, the posterior portion of the membrane and the incus being destroyed, the stapedius remaining in the oval window, and the stapedius muscle having thus ceased to perform any useful function, which was to prevent the stapes being driven too far into the oval window when the malleus was drawn inwards by the tensor tympani. Under the conditions previously described, the muscle draws outwards the anterior portion of the footplate, and a distinct improvement in hearing will be obtained by section of the tendon.

II. In Suppurative Otitis.

Ossiculectomy, including the Removal of the Remains of the Ossicles, Drum, and External Attic Wall.—The operation of ossiculectomy originally consisted in the removal of the remains of the drumhead and of the larger ossicles only. It is now made to include, in addition, the removal of as much of the external attic wall as can be cut away and removed through the external meatus.

It is an operation by which the surgeon attempts a cure without resorting to a radical operation on the mastoid in troublesome cases of prolonged chronic discharge from the middle ear; it is only to be employed where the temporal bone is not carious, and it cannot be successful unless the antrum be so situated that efficient drainage is possible. It should not, as a rule, be performed until the patient has been under treatment for chronic suppuration for at least three months. It is chiefly indicated where the patient finds it impossible to give up his occupation for the length of time necessary in order to undergo the more serious mastoid operation, since a week's rest in bed usually suffices after ossiculectomy to permit his safe return to duty, provided he remains under observation and has the wound dressed regularly.

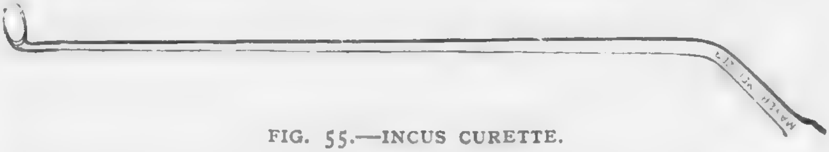

FIG. 55.—INCUS CURETTE.

The indications for removal of the ossicles may be taken to consist in: (1) A suppuration of more than three months' duration where ordinary treatment has failed; (2) when suppuration has ceased, and the consequent cicatrization has bound down some of the small bones of the ear by scar-tissue and has rendered the patient deaf, if, in the light of known facts (see tuning-fork tests), the aural condition will be improved by operative procedures.

Preliminary Preparations.—Twenty-four hours before the time elected for operation the ear should be thoroughly cleansed by irrigation with peroxide of hydrogen of the strength of 10 volumes, after which it should be thoroughly syringed with 5 per cent. carbolic acid; the meatus is then plugged with a strip of gauze wrung out in the same solution, the gauze being left *in situ* until the time of the operation. A general anæsthetic is necessary, and the operation is performed with the aid of reflected light. If the recumbent position is used, the operator must bear in mind the altered appearance that the drum will present, the malleus appearing to lie horizontally instead of vertically. After the packing is removed, the ear must be carefully dried with pledgets of sterilized cotton-wool, care being taken to avoid as far as possible any injury to the tissues, which might cause bleeding, and so obstruct the view.

Operation.—A blunt-pointed myringotome is now inserted in front of or behind the short process of the malleus, and carried in a circular direction completely round the drum at its junction with the meatus. The line of incision must be kept as close to the bone as is possible, and completed at the opposite side of the malleus to that on which the knife was inserted. The knife is then withdrawn, and the malleus firmly seized with a pair of strong forceps—preferably Hartmann's—as far above the short process as is possible. The malleus thus gripped is then drawn downwards and outwards, thus rupturing the ligaments and tensor tympani tendon, and at the same time removing the remains of the membrana tympani. Many operators prefer removing the malleus by Delstanche's extracteur. The loop of this instrument is made to embrace the handle of the bone, and has its sharp edge upwards; upward movement severs the tendon when the sharp edge strikes it, and the bone is then removed by pulling downwards and outwards. The loop of an incus hook is now inserted into the attic, so as to occupy the site previously occupied by the head of the malleus. When in this position it is rotated backwards, so that what remains of the head of the incus is embraced in the loop, and then by a downward and forward movement the incus is dislocated into the cavum tympani, and if not removed by the loop of the curette, it may be cleared away either by syringing or forceps. All bleeding is controlled either by a cotton-wool plug soaked in adrenalin solution, or by irrigation with hydrogen peroxide of the strength of 10 volumes; pressure is often all that is required. The external attic wall is now cut away either by means of a chisel. a cross-cut dental burr protected at the end, or by Krause's osteotome.

The bone should be ablated more posteriorly and superiorly than anteriorly, and an attempt made to remove the attic wall so thoroughly that a probe bent at the tip and passed into the attic may be withdrawn without encountering any resistance. The cavum tympani must now be curetted to remove all granulation tissue, and freely mopped out with Lister's strong fluid (*vide* Appendix) or pure carbolic acid. or pure carbolic acid and formalin (equal parts) ; the first solution is less often followed by facial paresis. The cavity is finally freely irrigated ; the antrum itself washed out by means of a dental cavity syringe, and Lister's strong fluid may be used for this purpose.

The meatus is firmly plugged with a long strip of sterilized antiseptic gauze, care being taken that the packing in the inner parts is firmly done.

After the operation slight vertigo may be complained of. This symptom is commonly transient, but it may persist for as long as two weeks. Facial palsy, more rarely than vertigo —also of a transient character—may be a sequence, and is due either to traumatism during the operation, or to inflammatory swelling in the Fallopian canal.

The dressings are to be changed as often as they become soiled, and the antrum irrigated at each dressing.

The operation itself affords extremely satisfactory results. Of fifty consecutive cases, no fewer than forty-two were cured, and it may safely be said that, with due care, in no case is the hearing-power diminished ; on the contrary, in nearly half the cases it is slightly improved. It must be admitted that there is a liability for a certain proportion of these cases to relapse, though this is not a large percentage ; and the operation itself may be considered, even when it fails in attaining its immediate object, as a useful preliminary to the radical mastoid operation.

III. Operations on the Mastoid Process.

Indications for operation on the mastoid may be divided into two great classes : (*a*) For acute cases, and (*b*) for chronic cases.

(*a*) *Acute Cases.*

1. Acute suppuration of the mastoid antrum.
2. Acute tuberculous disease of the middle ear.
3. Bezold's mastoiditis.

1. In all **Acute Cases of Non-tuberculous Mastoiditis,** and those which do not involve the whole or the major part of the cancellous or cellular portions of the temporal bone, the operation should be that which is designated 'Schwartze's operation,' which will be found fully described on p. 208. When a case of acute suppurative middle-ear disease becomes complicated by a secondary affection of the mastoid antrum, the temperature, if it had previously fallen, usually rises ; on the other hand, if it had not fallen, it continues high ; cases, however, occur, especially the post-influenzal type, in which extensive destruction of the mastoid is found unattended by any rise of temperature. Discharge from the ear may persist, may have been extremely transient, or may never have been present. A slight rigor is occasionally noticed. The patient may or may not complain of pain in the region behind the ear. In its earliest stages the symptoms of involvement of the antrum are slight and few. Besides those named there are swelling and a degree of redness of the posterior superior wall of the external meatus in its innermost portion. Tenderness will be elicited by pressure over the mastoid antrum, which lies just behind the auricle at a slightly higher level than the external meatus, and almost directly above it in children. Tenderness of the same kind may be found in other situations, especially at or in the region of the tip of the mastoid, or at a point about ½ inch below the site of the antrum, which may be taken to indicate either that the antrum itself is not the site of the abscess, one of the large cells in the mastoid being the affected area, or that the antrum is not the only situation in

which pus exists. The skin over the mastoid process may be slightly reddened. As the disease progresses, œdematous swelling will take place, first obliterating the post-auricular cleft, and afterwards causing the auricle to project outwards. If the patient remains unrelieved, pus accumulates beneath the periosteum, and deep fluctuation may be detected; he is further exposed to the danger of the pus finding its way into the cranial cavity, with its attendant risks.

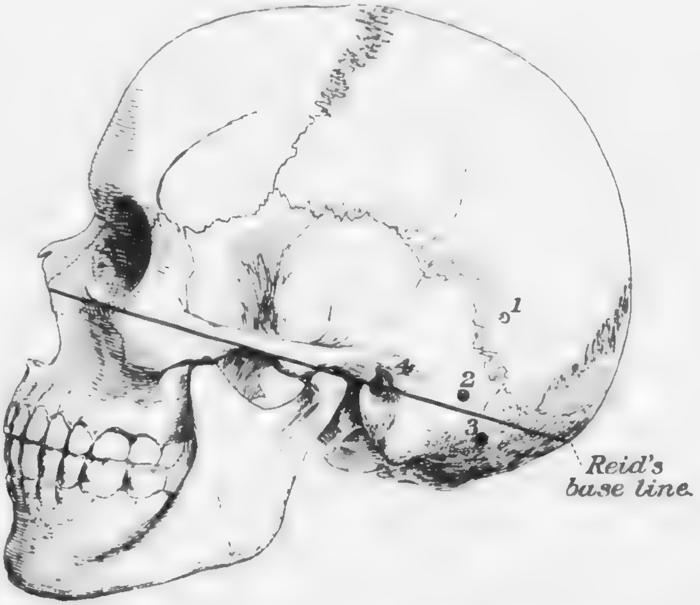

FIG. 56.—SHOWING TREPHINE CENTRES FOR OPERATIONS IN OTITIC INTRACRANIAL LESIONS.

1, Centre of trephine area for exposure of temporo-sphenoidal lobe; 2, centre of trephine area for exposure of lateral sinus; 3, centre of trephine area for exposure of cerebellum; 4, spine of Henle.

2. **Acute Tuberculous Disease of the Middle Ear.**—In acute tuberculous disease of the middle ear, if the treatment advocated on p. 127 is not successful in checking the disease within two weeks, an operation must be performed; but in this case it must be the complete or radical operation, to which the limit of the removal of bone is only that of the complete clearance of disease.

3. **Bezold's Mastoiditis.**—This condition will be found fully described on p. 125. When the surgeon is convinced that there is pus in the mastoid, and is of opinion, from the clinical signs, that the disease tends to the condition known as 'Bezold's mastoiditis,' he must sanction even less delay than if pus were confined to the mastoid antrum.

Post-Influenzal Mastoiditis.—One feature in this variety of disease is that the microbic (commonly diplococci) invasion of the antrum is not always preceded by a discharge from the external meatus ; and another, that if the antrum is not opened surgically at the earliest indication of trouble, there is a greater risk of serious brain mischief than in ordinary acute mastoiditis. Secondary deafness and mastoid pain are complications of influenza, and should cause an immediate inspection of the ear and mastoid process, tenderness over the mastoid being a sufficient indication for immediate operation ; the part lying immediately subjacent to the tender area ought to be carefully explored for an isolated purulent focus. A normal or subnormal temperature must be ignored in post-influenzal cases, as there is often nothing in the temperature to point to the least danger, even when pus is found in the sigmoid groove.

(*b*) *Chronic Cases.*

Indications for Operation in Chronic Suppurative Diseases : Acute exacerbations of chronic suppurative middle-ear disease.

In chronic suppurative disease, where skilled treatment carefully carried out for a reasonable length of time—namely, about six months—has failed ; where, in children and young adults, adenoid vegetations have been removed without curing the aural suppuration ; and where the minor operation of ossiculectomy appears to offer no hope of cure.

Constantly recurring attacks of suppuration in the middle ear, especially if associated with giddiness or pain.

Facial paralysis in chronic suppurative conditions.

Recurring polypi.

Cholesteatomatous disease of the antrum.

Lateral vertigo on syringing.

Persistent mastoid pain with suppuration.

Contraction of the external meatus, or the presence of an exostosis occluding the canal, when suppuration is present in the middle ear.

Mastoid fistulæ, external or internal.

Necrosis of the temporal bone.

Tuberculous disease of the middle ear and temporal bone.

As a preliminary to more extensive operations undertaken for the relief of intracranial complications.

Acute Exacerbations in Chronic Discharge.—In a case of chronic suppurative otitis media, with vertigo and perhaps sickness, tenderness will usually be elicited over the site of the antrum; lateral nystagmus is occasionally present, and in most cases there will be elevation of the temperature, though pyrexia is by no means constant. Swelling of the posterior superior part of the external meatus is sometimes present, while, in other cases, all discharge will temporarily cease. Tenderness over the mastoid antrum in chronic cases is of itself sufficient indication for the radical operation; much more will it be so if accompanied by any of the above symptoms.

Facial Paralysis.—This indicates a necrosis in the petrous bone, and if left untreated is a frequent precursor of extension of the disease to the meninges of the brain, and so imperatively demands early operative interference.

Cholesteatomatous Degeneration.—If the attic alone be involved operation may be delayed until the condition has proved incurable by the other methods; when cholesteatomatous degeneration has attacked the accessory cavities of the ear, and an attempt to obtain a cure by means of solvents, etc., has failed.

Lateral Vertigo on Syringing may be taken to mean that the membranous external semicircular canal on that side is exposed by erosion of the bone. This exposure of the soft parts of the labyrinth is usually a sufficient indication for operation.

In **Persistent Mastoid Pain** the object of operation may be more to relieve pain than to cure the discharge. But this is never an indication for operation when suppuration is not present.

Contraction of the External Meatus, with the presence of suppuration behind the obstruction, gives rise to a condition which is probably unequalled in gravity, as a steady destruction of tissue will proceed unattended by any symptom sufficiently marked to arouse the apprehension of the patient ; the most trifling febrile state, or the slightest acute inflammatory condition in the region of the ear, may lead to a rapidly fatal issue.

The Choice of Instruments for Operations on the Mastoid.

In operating on the mastoid, one may choose between three general methods of operative interference, one with the cutting gouge, another with the hammer and chisel or gouge, and the third by means of the burr, whether driven by electricity or by hand power. The burr and the cutting gouge have advantages over the method in which the hammer is employed, which should render them so far superior as to practically prohibit the employment of the hammer in performance of operations on the mastoid process.

In all methods of operating the same amount of skill can be acquired, but probably the cutting gouge is the more easy to manipulate, and although in the hands of a novice it may rather tend to slowness, yet the danger attending on its use is far less than that of the chisel and hammer. There is far less danger of cutting into important structures, and also if the hammer is used a modified form of concussion of the brain is caused, and many patients suffer for a considerable period from a prolonged convalescence, which seems to be largely due to the amount of concussion caused by the operation.

But by no means the least important aspect of the choice of instruments is that, apart from the concussion, the amount of shock is materially increased, and, as will be seen by the Arris and Gale Lectures for 1912,* at each stroke of the hammer a distinct shock is given to the patient's nervous system, whereas if no hammer is used the shock of the operation is minimized. The more prolonged the operation, therefore, with the hammer and chisel, the greater the amount of shock, as well as of concussion, that is experienced by the patient.

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* H. Tyrrell Gray and Leonard Parsons, *British Medical Journal*, May 4, 1912, p. 1006

In employing the cutting gouge, such as is figured in this book, the principal points to remember are that the weight is the piece of bone to be removed, that the fulcrum is the point at which the bevel starts from the main line of the instrument, the power being, of course, the hand. The gouge should be held so that the head rests comfortably in the hand, the index finger lying along the gouge, which finger should project slightly beyond the edge of the gouge, at any rate until the operator is thoroughly practised in its use. It is better not to make a directly straightforward cut, but to slightly twist the gouge as one cuts forward, something in the manner of a screw. But, like all instruments, it is better as far as possible that the operator acquires some little proficiency on the cadaver, or even on a piece of hard wood or skull.

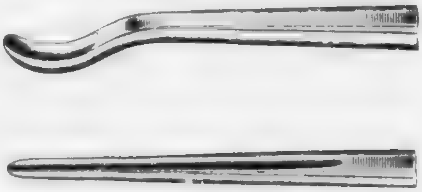


FIG. 57.—LABYRINTH GOUGES.

The objection to the burr is the slow pace at which one has to work, but for all that it is an extremely useful instrument, and one which will give confidence frequently to inexperienced operators. But if the student is really desirous of doing good work, no better recommendation can be given with regard to the choice of instruments than for that individual to attempt to see as many different surgeons as possible performing the operation, as the technique of each will vary somewhat, and those points which appeal to him may be selected from each one.

Simple Opening of the Mastoid Antrum.

Schwartze's Operation.—This operation includes the opening of isolated abscesses in the mastoid, as well as abscess of the antrum.

The operation about to be described is one that is performed *only in acute cases*, and is not suitable for chronic disease, as it has for its object the opening and drainage of an acute abscess. For this reason the incision in the skin is much shorter than that required in the radical operation; the bone is not removed to the same extent, and neither the bony nor cartilaginous wall of the external meatus is interfered with. It may happen that the whole mastoid process may be disorganized, or that pus has even perforated the deeper aspects of the bone, and travelled along the fascial planes of the neck; in such cases the area of bone removed in eradicating the disease may be considerably greater than that which is usual in the radical operation. However, even under such exceptional conditions, it is not necessary to remove the posterior wall of the meatus unless the disease be tuberculous.

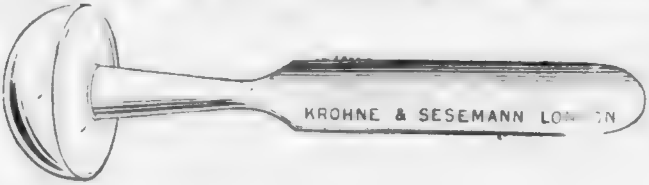


FIG. 58.—MASTOID GOUGE.

These gouges are made in sets of four, all fitting into the same handle, or they may be had separately, with mushroom handles.

Preliminary Measures.—The surrounding skin should be shaved for some 2 or 3 inches from the ear, and carefully washed with soft or ether soap, the external meatus irrigated with 1 in 3,000 hydrarg. perchlor. or 5 per cent. carbolic, and packed with wet antiseptic gauze; the ear and shaven area are well washed with the same antiseptic, and a wet antiseptic dressing applied; this should be done, if possible, at least twelve hours before the time of operation. A thorough cleansing is carried out when the dressing is removed under anæsthesia, just before the commencement of the operation, and the ear well syringed out with 5 per cent. carbolic acid solution.

The skin incision should be vertical or curvilinear, about 1½ inches in length, with centre lying over the antrum, or special site of pain. The tissues are divided down to the bone, and periosteum raised with a periosteum elevator; the sides of the wound are now held apart with retractors by an assistant. If the antrum be the seat of disease, the bone is carefully cut away for an area which should be limited anteriorly by the bony meatal wall, and superiorly by the posterior end of the temporal ridge; and the opening in the bone should not be larger than is requisite for comfortable working. The guide to the antrum is the spine of Henle or the posterior superior spine of the meatus, while a line parallel to the posterior superior part of the bony meatus will give the direction for the passage which must be made in the bone in order to open the antrum. When the depth of ½ inch has been reached, care must be exercised that the facial nerve be not injured. This accident will not occur if the centre of the wound corresponds with the junction of the superior and posterior walls of the meatus, and if the excavation be carried out without rashness, the bone being removed in thin films. The chisel, if used, must not be driven in perpendicularly. The surface of the wound is to be gradually enlarged superiorly, if necessary, so that the operator may work easily. A fine steel probe as a pus-searcher is constantly

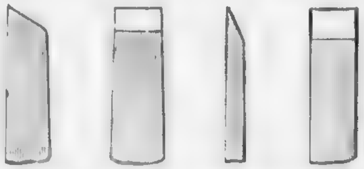


FIG. 59.—CHISEL POINTS.

It is well, when cutting away the posterior meatal wall and external attic wall, to use a high-pitched cutting edge like that on the left.

used, and when it enters the antrum the channel so obtained is carefully enlarged until the whole antrum is exposed. An incision should now be made through the posterior part of the drum, and an antiseptic solution syringed through the meatus into the wound, and *vice versa*. All particles of diseased tissue are carefully removed from the antrum, and any diseased cells by means of the curette, search being made for small sinuses in the bone leading to isolated foci of disease; the whole wound is swabbed out with Lister's strong solution dusted with iodoform, or filled with iodoform emulsion, and packed with antiseptic gauze. The skin-flaps are now sutured together, with the exception of a small portion towards the lower end of the wound, through which the end of the dressing protrudes.

Subsequent dressings consist in keeping the meatus clean, by means of carbolic acid douches and careful plugging with antiseptic gauze, until all discharge has entirely ceased. The wound is allowed to granulate from the bottom, reducing the gauze plugging as occasion requires, but it is not necessary to allow the wound to be entirely filled up before allowing it to cicatrize over, so long as no discharge is present. The cavity is packed with mixed iodoform and boric acid, or filled at each dressing with iodoform emulsion (see Appendix).

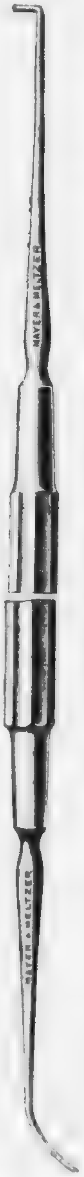


FIG. 60.—PUS-SEARCHER.

Operation in Bezold's Mastoiditis.

It is well to bear in mind that before perforation of the inner table of the mastoid process can take place certain anatomical peculiarities must exist. Such a condition cannot occur unless the mastoid process consists almost entirely of cells, with the minimum amount of diploë and a relatively thin outer shell of compact bone. It is invariably found that in these cases several cells of large size communicate with each other and with the antrum, one of these, more constant than the rest, being situated over the digastric groove in the under surface of the mastoid bone, and merely separated from the groove by a layer of bone scarcely as thick as an egg-shell (Fig. 14). Pus gaining entrance into the digastric fossa may find its way into other abnormal situations; thus, for instance, it may present at the naso-pharyngeal extremity of the Eustachian tube, burrow down the neck beneath the sterno-mastoid, or appear behind this muscle in the suboccipital region. As a result, however, of the more general knowledge of aural disease, it is rarely that we find cases so far advanced; but the whole mastoid will more frequently be found full of pus and granulation tissue when the operation is undertaken, especially where pain was previously complained of on pressure in the region of the digastric fossa.

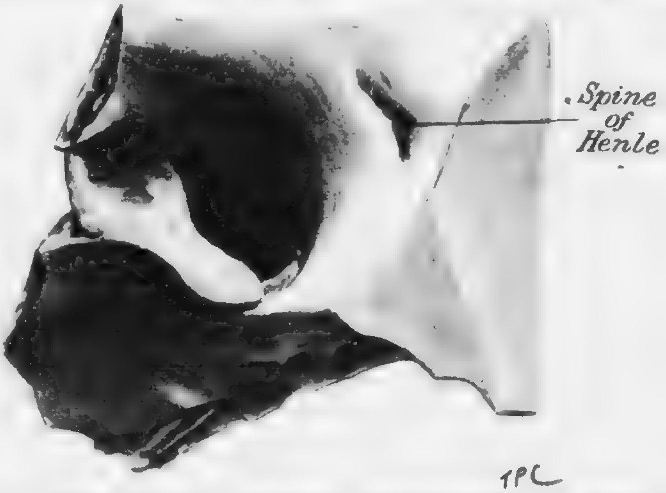


FIG. 61.—LEFT EXTERNAL MEATUS, SHOWING SPINE OF HENLE.

The same preliminary treatment is necessary with regard to antiseptics and shaving that has been described for other operations on the mastoid. An incision to the bone is made commencing just above the insertion of the auricle, and is carried crescentically backwards well within the hair margin and brought down if necessary into the neck. When the bone has been exposed, the cortical portion should be rapidly and freely removed, when pus will be found in most, if not all, of the cells opened. By means of forceps, curettes, and gouges, all diseased tissue should be freely removed, no matter how wide and extensive a cavity such radical measures may cause. It may even be necessary to remove the whole of the mastoid process and to lay bare the lateral sinus for some length in order to remove all traces of the disease. The antrum should be sought for, but if the surgeon cannot successfully differentiate this cell—a determination by no means always easy under these conditions—the bone is to be removed in order to afford an entry into the attic. The membrana tympani is now freely incised, and the middle ear and attic washed out with an antiseptic solution, and an attempt made to wash through from the post-auricular wound into the tympanum. The whole of the bottom of the cavity of the temporal bone is freely mopped with one of the strong antiseptic lotions recommended previously. The wound is now to be dusted with iodoform or iodoform emulsion, filled with antiseptic gauze, and sewn up, with the exception of a small portion of the lower angle to permit of plugging, and the meatus plugged to the bottom. The treatment subsequent to the removal of the packing consists in the insertion of a drainage tube, and at each dressing the cavity is simply filled with iodoform emulsion through this tube, which is shortened as required. The external meatus, if pus still persists in this direction, is irrigated frequently with antiseptic solution and plugged.

Pus, when present in any other situation, must be evacuated and the cavity treated by ordinary surgical procedures.

Although the amount of bone removed in these cases is very large, healing is extremely rapid and the consequent deformity very slight, while the hearing is but rarely affected. If, after healing, there is an unsightly post-auricular deformity, subcutaneous injections of paraffin wax may be used to restore the normal contour of the part.

It is now rare to find a permanent opening behind the ear after a mastoid operation, though formerly this was by no means uncommon. Should such an opening unfortunately be left, a plastic operation is required to close it.

The Radical Mastoid Operation.

During the last two decades operations on the temporal bone have been so much improved that it is not practicable in a work of this size to apportion due credit to those workers through whose skill and ingenuity we have obtained the present excellent results. It is customary to give the name 'radical operation' to one which is intended to remove the whole of the disease, and at the same time to throw the middle ear, the external meatus, the attic, and antrum into one large cavity.

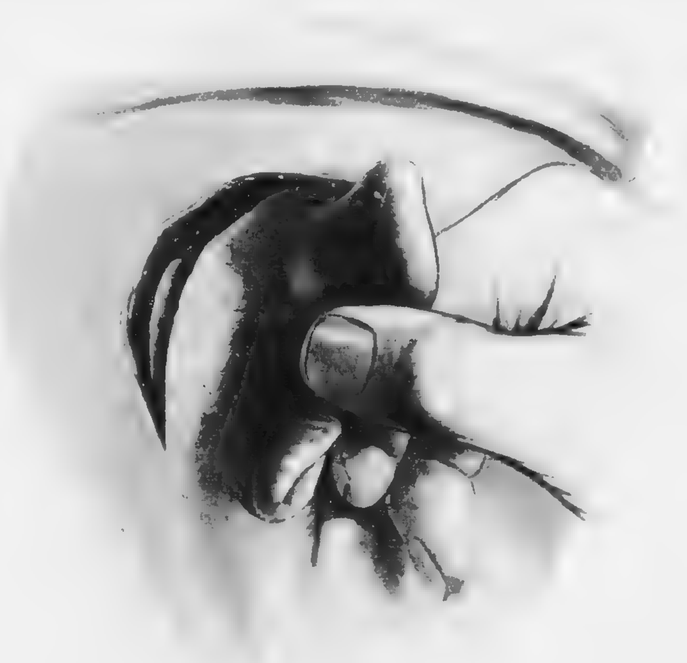


FIG. 62.—THE INCISION FOR THE RADICAL OR COMPLETE MASTOID OPERATION.

Preliminary Preparations.—The head should be shaved for 2 or 3 inches from the ear. The skin of the ear and of the side of the head, the neck, and face are to be thoroughly washed with ether soap and well scrubbed with a nail-brush twelve to twenty-four hours before the time of operation. At the same time the external meatus is well irrigated with 5 per cent. carbolic acid.

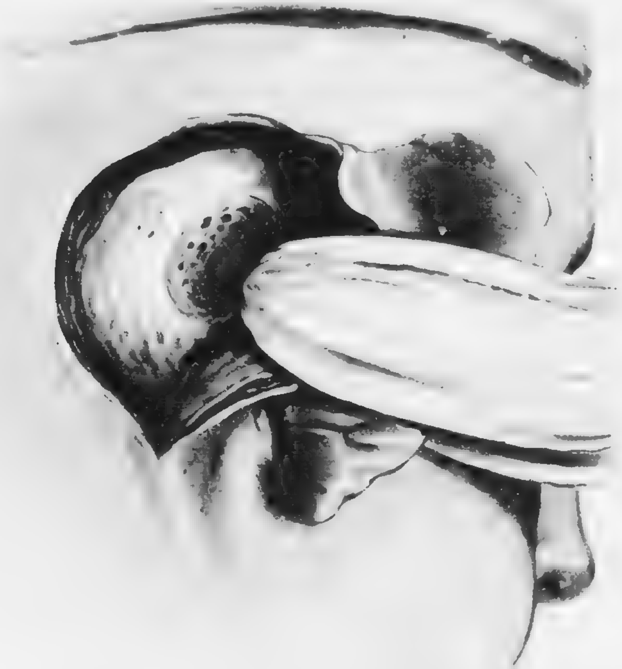


FIG. 63.—THE EARLIER STAGE OF THE RADICAL MASTOID OPERATION.

The bone has been cut away to show the method adopted in cutting down to the antrum. The ear is held forward by a loop of bandage, passed through the external meatus.

The external meatus is plugged with antiseptic gauze soaked in a lesser strength of carbolic solution, and a moist antiseptic dressing placed over the ear and site of operation.

At the time of operation the parts are again well soaped and scrubbed, and treated with antiseptics in the usual way; ½ per cent. formalin is a most useful solution. A sterilized towel, or one soaked in 2 per cent. carbolic acid, is now bound round the head in such a way as to enclose all the unshaved portions of the hairy scalp. An incision is then made, commencing ⅓ inch above the superior anterior insertion of the auricle keeping the incision within the shaved edge of the hairy scalp, but at the bottom curving forwards to the apex of the mastoid process. The incision must be cutaneous for the first inch or 1½ inches, but in the rest of its extent the knife is passed down to the bone. The reason for this difference in the anterior and superior part of the incision is to avoid dividing the temporal fascia and muscle. The flap

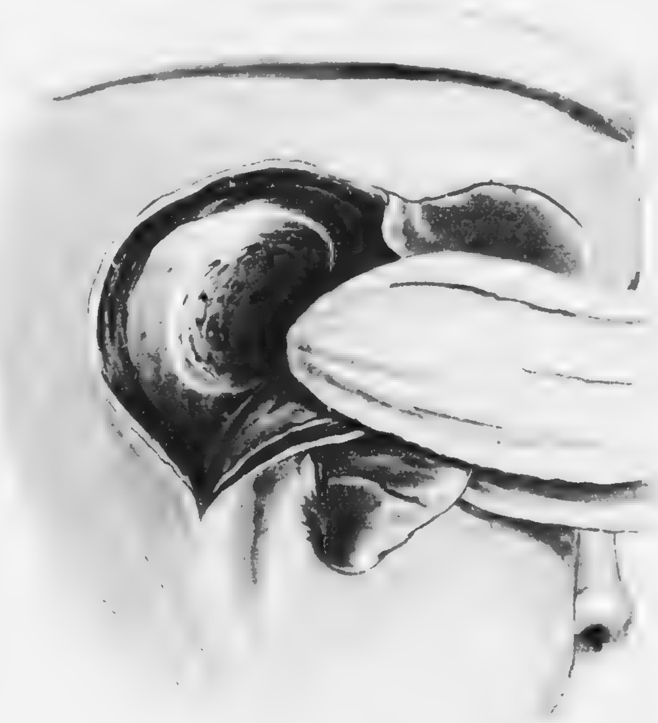


FIG. 64.—THE ANTRUM OPENED.

The bone between the antrum and meatus is the 'bridge.'

marked out, with the whole of the subjacent tissue, including the periosteum, is dissected forwards and all bleeding-points secured. It is advisable that every vessel, however small, be picked up, as oozing from the flap materially retards the later steps of the operation. The surgeon now defines the posterior and superior edges of the bony meatus, and by means of a small elevator or probe separates the upper and posterior parts of the cartilaginous meatus from the bony tube. The next step is to divide the cartilaginous meatus into anterior and posterior halves by means of parallel incisions through its upper and lower walls, these incisions being carried well up to its junction with the skin of the concha. A piece of bandage, previously sterilized, is passed through the external meatus, and has its ends knotted into the form of a loop. This is given to an assistant, who uses it as a retractor, and pulls the external ear forwards. It is better now to define the posterior superior meatal spine (p. 3), as this is the anatomical guide to the antrum, which may be reached by cutting through the bone parallel to, and closely behind, the posterior superior angle of the bony meatus.

The bone is now attacked either with a gouge, chisel, or electric burr. If done by one of the two former instruments the process should be commenced on a level with the floor of the meatus in such a way as to remove the cortex from an area of about $\frac{1}{2}$ to $\frac{3}{4}$ inch in vertical diameter, and $\frac{1}{3}$ to $\frac{1}{2}$ inch in antero-posterior or horizontal direction (Fig. 63), cutting away the posterior wall of the canal and part of the superior with the rest of the bone, working gradually inwards, with a slight direction upwards, having the centre of the cavity at a point corresponding as nearly as possible with that originally occupied by the spine of Henle. The posterior curve of the bony opening should correspond to the curve of the skin incision, and should be limited above by the posterior part of the temporal ridge alluded to on p. 4. As the surgeon cautiously works his way inwards, removing as he proceeds the entire posterior wall of the meatus, together with a considerable amount of the superior, he should estimate the distance he still has to traverse by means of a small metal hook—as a strabismus hook—or bent probe passed into the aditus. This will inform him of the amount of bone still to be cut away, and show him the direction in which to seek for the antrum. He will do well to employ this precaution more frequently as the wound becomes deeper. When the antrum has been opened (Fig. 64), as will be ascertained either by the exit of pus, or by the direction and depth to which a steel pus-searcher can be inserted, he will proceed to enlarge this opening forwards and upwards so as to define that portion of the posterior meatus which bridges over the aditus, and which yet remains to be removed. It is customary to speak of this remaining portion of the external meatus as *the bridge,* and it is this portion which next has to be removed. This can also be done by means of a small pair of bone-forceps or by means of the mallet and chisel, and it is well for inexperienced operators to insert a few pieces of sterilized sponge under the

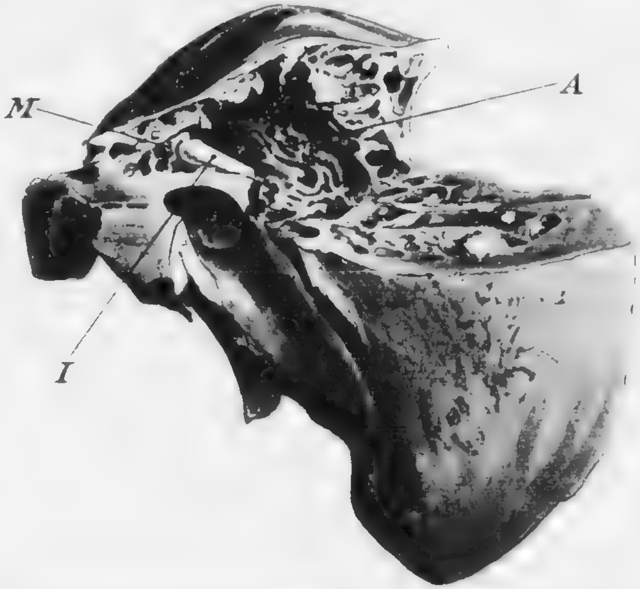


FIG. 65.—SECTION OF LEFT TEMPORAL BONE SHOWING THE CAVITY OF THE ANTRUM AND ITS RELATIONSHIP TO THE EXTERNAL MEATUS. THE CAVITY IS UNUSUALLY LARGE.

A, Antrum ; M, head of malleus ; I, body of incus and short process.

bridge in order to protect from injury the external semicircular canal, which lies immediately beneath this bridge of bone. If a burr is used it must have a protected end, in order that the bridge may be divided without damage to the deeper parts.

When the operator has become thoroughly efficient in the use of the cutting gouge, he will find the necessity for the employment of the hammer and chisel for the removal of the bridge quite unnecessary, and that he will be able to cut the whole portion away with the smallest of the gouges.

After having opened freely into the antrum, and cut away all the bone overlying the remnant of the so-called bridge, the outer attic wall should be cut away as far as possible with the smaller gouge, beginning at the tympanic margin. This is rather a difficult thing to describe clearly, but with a little practice even that small amount of hammering otherwise required can be saved, and probably time is saved here as well ; though operating for rapidity is a thing that should not be attempted, but if quickness comes with practice so much the better.

Immediately beneath this bridge (with the patient lying on his side) lies the projection formed by the horizontal semi circular canal, and the facial nerve passes directly outwards and then downwards lying in the small projection of bone left below after the removal of the bridge. It is now well to remove by means of a pair of fine forceps any remains there may be of the ossicles. Small portions of sterilized sponge may be packed into the attic and its external wall cut away by means of a chisel ; an oval burr may be preferred, in which case the pieces of sponge are not required. The external attic wall must be so fully removed that a bent probe introduced into the attic and drawn outwards meets with no obstruction. With a fine probe careful search is made for sinuses leading to diseased areas not yet exposed. If any are found, they must be followed up carefully. Small sinuses are sometimes seen in the external semicircular canal, more rarely in the posterior, as it is seldom seen in these operations. Such sinuses should, however, not be either probed or followed up with the burr and chisel unless there are symptoms which have led the surgeon to believe that the labyrinth is also the seat of suppurative disease. Destruction of the bony roof of the attic should lead to a careful search for any perforation of the dura in the immediate environment, as a cerebral abscess may discharge its contents by this route. With the gouge, chisel, or dental burr the cavity is rounded off as well as possible. When there is a desire to inspect fully the cavity of the middle ear on account of symptoms pointing to involvement of the labyrinth, the posterior wall of the meatus, which now appears as an inclined plain, must be cut away more completely, keeping the cut surfaces flush with the meatal floor, and working inwards until the level of the floor of the aditus is almost reached. Here particular care is necessary not to wound the facial nerve. It often happens during the operation that annoyance is experienced from bleeding vessels in the cut bony surface. This may be immediately remedied by crushing a little sterilized wax into the bleeding orifice. All granulation tissue, together with diseased mucous membrane in the middle ear, must be removed freely with a curette. In fact, if it is proposed subsequently to employ skin-grafting, no particle of mucous membrane must be left behind, as it seriously interferes with the successful growth of the graft, especially in the neighbourhood of the Eustachian tube. It is important to cut off the wound cavity from the nasopharynx either by well scraping down the tube, so as to cause a cicatricial atresia, or if the tympanic membrane is fairly well preserved it may be left, in order by adhesion to the inner tympanic wall to obtain a like result. All the deep surfaces of the attic and other places where the bone is at all soft are thoroughly curetted, and the whole of the bony cavity swabbed with Lister's strong fluid.

The meatal flap described on p. 216 is now reduced to a skin flap by dissecting off as much of the connective tissue and cartilage as possible, continuing this removal as far into the tissues of the auricle as can be done without encroaching on the cartilage of the concha. This skin flap is now drawn backwards, and attached to the raw surface by two or three sutures in such a way that, when the auricle is replaced, this skin flap corresponds with the hole that has been cut in the mastoid bone. The sutures should pass completely through the skin, so as to be removable from without. It is advisable to stretch the external orifice of the meatus to insure ease in subsequent dressings. The wound is finally carefully dried, powdered with iodoform, and packed with a strip of antiseptic gauze tightly from the bottom soaked in iodoform emulsion, and its free end carried through the external meatus. The post-auricular wound is closed by means of sutures and a suitable dressing applied. When closing the post-oral wound, it is well to commence the stitches with the middle one, but taking care that the anterior margin is attached rather higher up than appears to be necessary. By so doing, one prevents the ear falling, which it is very apt to do if the stitches are put in so that the two edges appear to be correctly approximated. It may be noted that it is not necessary to put any portion of the bandage under the chin, a plan which adds greatly to the comfort of the patient during the first twenty-four hours.

Subsequent dressings consist in packing a long strip of sterilized gauze through the external meatus, so as to entirely fill the wound cavity. These dressings should be changed as often as any discharge shows through the external dressing of two or three layers of gauze covered by cotton-wool. The most comfortable method of keeping the first dressing on is to employ the figure-of-eight turban-wise, not going under the chin. For the subsequent dressings the shield shown on Fig. 66 is very convenient and light, being made of vulcanite.

In the above operation there are two dangers to be borne in mind; one is that of wounding the lateral sinus, the other that of injuring the facial nerve. There is also the possibility of exposing the dura mater of the middle fossa; but if this last accident should happen, it is quite free from danger. The situation of the antrum is constant, and its relationship to the facial nerve is practically constant, though the position of the lateral sinus is unfortunately not so. The general configuration of the skull is largely responsible for this irregularity.

In the proportionately long skulls the sinus is situated more posteriorly than in those in which the head is relatively broad. It is in the latter type that the middle fossa is apt to be opened.

Facial Nerve.

The facial nerve, which, in its usual course, lies just out of the danger zone in operations on the mastoid—even the more extensive ones required as a preliminary to labyrinthine operations—may, and occasionally does, come very far forwards. It is said, indeed, to pass above the aditus, coming then close down behind the posterior wall of the external meatus, and may lie so far external to this usual course as to be found within ½ inch of the surface of the bone. In these occasional variations the facial nerve must lie exposed to certain division if an operation has to be undertaken in such a case. Hence the necessity that exists for the close observation of the patient by the anæsthetist, and his instant report of any twitching of the face during the operation. Section of the facial nerve causes one spasm of the whole of the facial muscles on that side, a spasm which is never repeated in any form during the operation. If this spasm comes early in the operation, the facial is divided, and should be immediately searched for.

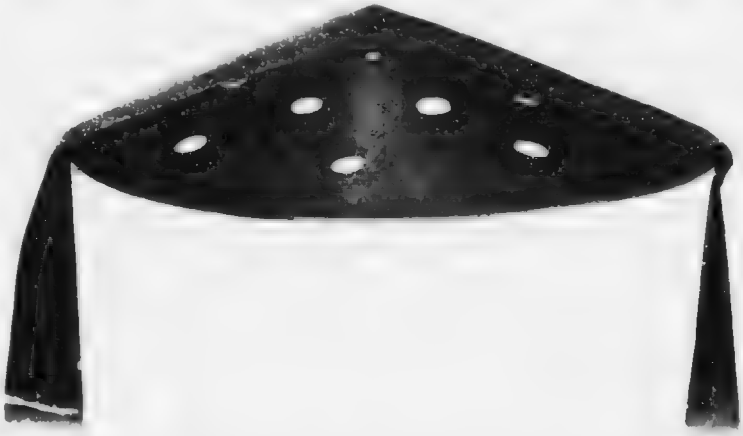


FIG. 66.—VULCANITE SHIELD FOR RETAINING DRESSING ON THE AURAL WOUND AFTER MASTOID OPERATIONS.

The nerve should then be carefully lifted out of its canal as that canal is opened, the greatest possible care being taken that whilst so handling the nerve the least possible amount of traumatism be inflicted, and the operation as was originally intended should be completed before any steps are taken towards reuniting the divided nerve. When the original operation has been completed, the distal end of the facial as it lies in the bone should be followed up until the nerve is exposed in its whole intra-osseous course. The ends are then easily brought into apposition, and must be carefully attached to one another by sutures, and should the operator have a small decalcified bony tube the nerve may be enclosed in one as far as possible before suturing.

The distinctions to make between the section of the nerve and the scraping or bruising of an exposed portion of it, are that when the nerve is only pressed on or scraped, or otherwise stimulated, but not cut, only a portion of the facial muscles will twitch, commonly the muscles of the eyelid and its neighbourhood, and they will twitch again if the manœuvre which produced the original twitch is repeated; whereas, as is stated before, in the event of complete section one general spasm alone is noticed, and cannot be reproduced without the aid of a galvanic current.

Section of the facial nerve should only occur when the nerve is lying in an abnormal situation, and it seems that no care is likely to protect that abnormally lying nerve. But with the nerve in its normal situation its division should never occur.

Treatment of Divided Facial.—Beyond the method alluded to previously of immediately suturing the divided nerve, which is only possible where no portion of the nerve has been removed, the next best procedure is to attach the nerve to the hypoglossal. The hypoglossal is exposed by an incision commencing at the anterior border of the sterno-mastoid muscle, which is carried down some 3 inches. By a careful dissection, one should be able to pick up the facial nerve just as it enters the parotid. It is then carefully followed back as far as the sterno-mastoid foramen. One is then at liberty either to divide the nerve at this point, or to dissect it out by removing the bone so as to obtain a rather longer portion of the nerve. The hypoglossal is then found crossing the wound transversely at the lower border of the digastric muscle. This nerve is then divided, and the facial nerve attached to the proximal extremity, the greatest care being used to injure the nerve as little as possible; the transverse process of the second cervical vertebra is a useful guide to the situation of the hypoglossal.

Fully six months is usually required for the nerve to commence again to exercise its function, but massage to the facial muscles should be commenced immediately after section of the nerve, and this combined with galvanism should be steadily persisted in until complete recovery is obtained. The loss of muscular power to the tongue on that side will cause a considerable amount of inconvenience until the patient has become accustomed to the altered condition, and will to a certain extent interfere with speech, as well as perhaps involve a certain amount of injury to the tongue by the teeth, but this will not be of very great duration, and will not be the source of permanent annoyance.

The lateral sinus on the left side lies somewhat more anteriorly than on the right, but as a general rule the vessel lies about ¼ inch behind the external meatus. Should it be exposed during the operation, reasonable care will prevent injury, and no ill-effects will follow.

Injury of the lateral sinus is evidenced by an alarming rush of dark blood. The hæmorrhage must be temporarily checked by the finger, and a long strip of iodoform gauze pushed up *between* the sinus wall and the groove in which it lies, and a second strip of gauze inserted in a similar way downwards. This packing may be removed at the end of forty-eight hours.

Skin-Grafting.

With a view of shortening the period necessary for cure, skin-grafting has been advocated. The graft may be applied immediately on completion of the operation, provided the absence of any caustic antiseptic is assured by free irrigation with sterile saline solution, or the wound is reopened at a later date. A large Thiersch's graft is applied covering the whole cavity as soon as the interior of the bony wound is covered with granulation tissue, or smaller grafts may be applied through the external meatus to such portions of the cavity as are easily accessible, or which seem most suitable.

The employment of skin grafts in certain cases, especially in the upper classes, has great advantages, but a second operation is involved in the above-mentioned method, at which numbers of people not unnaturally demur. Also, if the ear should again become the seat of suppuration, a condition in no way distinguishable from cholesteatoma is set up.

The after-treatment, if grafting is not employed, consists in changing the dressings less and less frequently as the discharge lessens, being particularly careful to plug firmly to the bottom of the wound, and to fill it equally in all directions, for unless this be done granulation tissue will form, and so diminish its size as to eventually completely occlude the cavity In fact, cases do occur in which this tendency to excessive granulation-tissue formation is so exuberant and persistent that, despite all efforts, the cavity is completely obliterated. For the first two weeks it is absolutely necessary that all fluids used for irrigating the operation cavity should have strong germicidal and somewhat caustic power. Two solutions which possess these properties are 5 per cent. solutions of carbolic acid and $\frac{1}{10}$ per cent. of corrosive sublimate. It is strongly advisable to bear in mind that, should septic changes be allowed to occur, the danger to which the patient is subjected is as great, if not greater, than if no operation had been performed.

As an alternative method of treatment one may, after a few packings, insert a rubber tube into the meatus as large as possible, and rely on alcohol instillations to cause a rapid cicatrization. This, though often successful, is apt at times to cause too rapid closure of the parts, and is of somewhat doubtful value.

When it is proposed to graft, it is well that the solutions used for irrigation of the cavity between the time of the first and second operations should not for the last few days be of caustic strength, as they tend to harden the granulation tissue which is formed, and do not leave a suitable surface on which to graft. The grafts are taken from the inner surface of the thigh, and too much care cannot be exercised in rendering the surfaces from which they are taken aseptic, the least neglect of the most scrupulous precautions being apt to lead to an increase of suppuration in the cavity after the graft has been inserted, and to the death of the graft itself. The part from which the graft is to be cut should be thoroughly washed with ether and soft soap, or with ether soap, forty-eight hours before the operation, scrubbed with a nail-brush, sponged with a mixture of ether and alcohol, and, finally, an antiseptic dressing carefully applied and kept in its place by a spica bandage. If the patient is one whose social position or habits of life have prevented the regular use of baths, a second cleansing similar in all respects to the first should be carried out twenty-four hours before the operation, and a fresh dressing applied.

The post-aural wound is reopened, the dressing removed from the cavity, which is then well irrigated with a sterilized saline solution, and curetted to remove all proliferating granulation tissue. It is then again cleansed with saline solution, and packed with gauze well soaked in adrenalin in solution, with a little pressure in order to check all bleeding by the time that the graft is cut and ready for application. The dressing from the thigh is removed, and the part from which the graft is to be cut sponged again with alcohol and ether. A sterilized bar of wood or iron is laid across the thigh parallel to and just below Poupart's ligament, and kept pressed firmly down and held by an assistant. The operator then with his left hand draws the skin of the thigh downwards, so as to render the surface flat. The graft is now cut with a heavy wide-bladed Thiersch's knife, and should be of sufficient size to line the whole cavity and obviate the necessity of employing a second. A little saline solution dropped upon the razor and the thigh as the graft is being cut assists in the ease with which the skin may be cut, and tends to prevent curling of the ablated skin. The graft is now transferred to a shallow dish containing warm sterilized saline solution. A dressing is applied to the thigh by an assistant, the most comfortable one being a piece of lint spread with aseptic ointment. The operator now exposes the mastoid wound, and, when all oozing is stayed, he proceeds to apply the graft, which is taken up on a large section-lifter and applied over the bony wound in such a way that its edges rest on the fleshy parts, above as well as in front and behind, any folding of the graft which may have taken place being promptly corrected. The graft is carefully worked down into the deeper parts of the wound by means of long needles fixed in handles, and is then pressed into its deeper recesses either by means of needles or by instruments specially constructed for the purpose, any moisture which has accumulated beneath the graft being sucked out by means of long glass pipettes, which are also useful in securing a close adaptation of the graft to the walls of the cavity.

After the graft has been applied as above, the wound is to be tightly plugged with a strip of sterilized gauze, well permeated with sterilized parolene, which is firmly pressed into the wound, thus keeping the graft in close apposition to the bone. The remains of the graft, which would otherwise lie outside the wound, are carefully turned forward over the gauze plug, so that the inner aspect of the flap not covered by the piece of skin taken from the posterior meatus shall receive an epithelial covering. It may be necessary, however, to apply a second small skin graft to this part. The wound is reclosed with sutures, and an antiseptic dressing applied.

It ought to be borne in mind that during this grafting operation no strong antiseptics are used, since they diminish the vitality of the graft.

The dressing may be changed on the second day—preferably on the third—the wound irrigated with sterilized saline solution or weak boracic lotion, and re-plugged. Occasionally the whole of the graft comes away within the first fortnight.

The reason of this will be because—(*a*) Too powerful antiseptics were used previously to the operation ; (*b*) the graft was too thick ; (*c*) a certain amount of fluid was left beneath the graft, which prevented its adhesion.

Besides the method of dealing with the external meatus which has been described, two other methods are worth consideration. The first is to remove the posterior half of the external meatus entirely. This rather shortens the operation, and at the same time removes the ceruminous glands, which, if transplanted and removed from their natural support, may give rise to trouble by filling up the operation cavity with a mass of cerumen.

The second method of dealing with the external meatus is to divide it horizontally through the middle of its posterior wall, and vertically at the junction of its posterior half with the auricle. When this procedure is adopted, great care must be taken to keep the meatal flaps pressed upwards and downwards until they shall have become attached in their new situations.

The clinical results of the radical mastoid operation are extremely good, and in a large majority of cases complete and lasting cure is obtained. It is most rare for the hearing-power to be injured, but, on the contrary, it is more frequently markedly enchanced, whilst the improvement in the general health of the patient is obvious to the most casual observer. Occasionally, however, it is necessary to operate a second or even third time ; nothing except experience, aided by the greatest care, will prevent these cases from cropping up now and then, and also the occurrence of post-auricular sinuses, due to the operation, should be prevented.

The Mastoid Operation of Kuster, or Semi-Radical Mastoid Operation.

This operation, recently restored to a place in aural operative surgery, deserves to be noted, as it is one which is of value in three classes of cases—viz., attic suppuration (either after failure of, or instead of, the simple procedure noted on

p. 162), and in those cases where the tympanic membrane is only destroyed in its upper and posterior part, where the tympanum is not involved, and where there is no suspicion of labyrinthine suppuration. It is also applicable to meatal sinuses with an intact tympanic membrane.

In this operation the posterior wall of the meatus is only cut away sufficiently to open the antrum and aditus, but if the antrum is large and extends low down, the operation is converted into a complete or radical one. Should, however, the disease be limited to the attic and aditus, and should the antrum be small or not diseased, then the operation is restricted so as to leave the membrane and ossicles *in situ*, whilst the external wall of the attic is freely removed. The wound is packed after thoroughly cleansing the parts as directed on p. 220, the meatus being merely divided lengthwise at the upper and posterior part, so as to push the edges well into the bony cleft, and subsequent packing employed.

After-Results of Operation.

Where healing takes place satisfactorily, whether this be due to antiseptic treatment or to grafting, hearing will be improved in a large number of cases. But where the hearing is already lost, as will be shown by tuning-fork tests, no relief can be experienced.

If healing does not occur it may be due either to some portion of the bony wound refusing to heal, or to a contraction by reason of excessive formation of granulation tissue; or suppuration may recur during after-treatment from carelessness. Healing may best be obtained by the application of a small skin-graft to the area still rebellious to antiseptic cicatrization. Excessive granulation may be kept down by the use of caustics, or, where necessary, of a curette. If the external orifice tends to contract, a large indiarubber drainage-tube should be inserted, and only taken out for applications to the cavity. The use of alcohol in the form of drops in these rebellious cases is often of extreme benefit, but cases will occur which tax the patience and ingenuity of the surgeon to the utmost. Sedative ointments may avail when astringents fail.

Post-operative neuralgia, chiefly in the course of the great auricular nerve, is sometimes complained of, and will yield to ordinary anti-neuralgic treatment, and to frictions with a mixture of chloroform, aconite, and belladonna liniments.

The hearing-power after a mastoid operation will depend upon, in the first place, the condition of the nerve, and will rarely be worse than before operation, and in a fair proportion of cases is exceptionally good, the improvement being marked. The condition of the stapes and the presence or absence of granulation tissue in the region of the oval window have a material influence upon the residual hearing. The stapes may be removed with advantage, provided the wound is thoroughly aseptic; but a base left in the niche without the cruræ will always give an indifferent result.

Operations on the Labyrinth.

A flap is formed in the following way: A scalpel is inserted into the meatus, with its edge directed forwards and upwards in such a way that the edge of the heel of the blade lies between the tragus and the commencement of the helix, the rest of the edge being directed between the junction of the anterior and superior walls of the meatus, in which direction the meatal wall is divided down to the bone (see arrow in Fig. 67). As the knife is withdrawn, the incision is carried upwards, close to the helix, until the upper border of the insertion of the concha to the head is reached; it is then carried backwards and downwards with a bold sweep, following much the same direction as is usual in a post-aural operation, but without bringing the lower part of the incision materially forward. The ear and external meatus are then dissected out and turned downwards, being, as it were, unrolled and laid on the tissues of the neck, below the angle of the jaw, and enclosed in sterilized antiseptic gauze, and held in place by a stitch. This method of dealing with the ear not only permits an excellent view of the parts, but enables one in working to avoid any possible injury to the meatal wall. At the same time, the auricle being absolutely removed from the field of operation, retractors are dispensed with ; also, as the wound is deepened, far more light is available in its deeper parts than is obtainable by other methods. An ordinary radical mastoid operation is performed, but the bone is cut away as much as possible in the upper and back part of

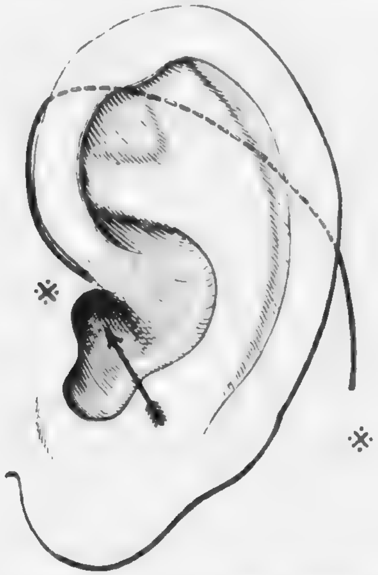


FIG. 67.—THE LINE OF AUTHOR'S INCISION EMPLOYED IN OPERATIONS ON THE LABYRINTH.

* * The line of incision, the dotted line the part of the incision hidden by the auricle. The knife is introduced with the edge pointing in the direction shown by the arrow, and the external meatus is divided in its whole length.

the bony wound. The bony external semicircular canal is well exposed to view. By means of a small gouge the whole of its upper surface is cleared from the more porous bone immediately superjacent. The upper surface of this external semicircular canal is then removed by the gouge, a burr or chisel, until the membranous canal is opened ; and it might be well to point out that the diameter of this canal does not exceed $\frac{1}{20}$ inch. The canal is then followed up along its anterior and posterior limbs, anteriorly until the increase in its calibre notifies the close proximity of the ampulla, and posteriorly until its slightly forward direction indicates the near approach to the vestibule. For the canals are not really semicircular, but rather exceed this. The next step in the operation is to obtain free access to the vestibule. This is done by joining with a burr or chisel these two openings as freely as possible,

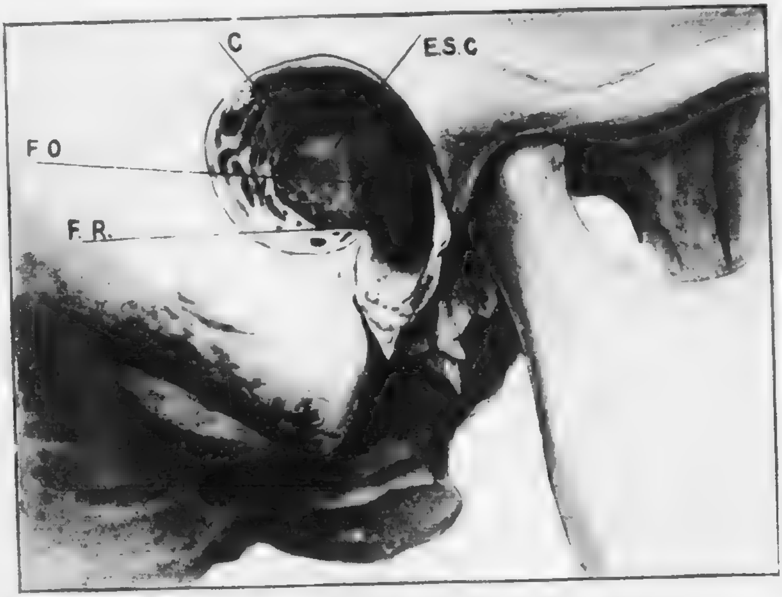


FIG. 68.—THE COMPLETED RADICAL MASTOID OPERATION.

ESC, External semicircular canal; *C*, a large deep mastoid or petro-mastoid cell; *FO* and *FR*, the oval and round windows. (The posterior meatal wall is not so completely cut away as for suppurative disease.)

and if this does not make a large enough opening, further room may be obtained by opening the posterior canal behind, and parallel to, the facial nerve. The opening into the vestibule is then enlarged in every direction by means of fine chisels (Fig. 70). The commencement of the superior canal should be freely opened, and its ampulla scraped out. It is more difficult to open the ampulla of the posterior canal, which is situated at a lower level. The posterior and superior canals are not interfered with, but the ampullæ are to be carefully curetted (Fig. 72). The next stage in the operation consists in freely opening the foramen ovale by abstracting the footplate of the stapes, so that no fluids could be retained in the opened vestibule, and enlarging the orifice as much as possible. The whole operation cavity is well curetted, cleansed with a strong antiseptic solution, and commercial formaline employed to wipe out the cavity of the vestibule, then well filled with oily iodoform emulsion, and packed with sterilized gauze, the end of which is brought out to the meatus, and the ear replaced, the greatest care being taken to see that the helix comes back into its original position. After-treatment as for a radical mastoid operation.

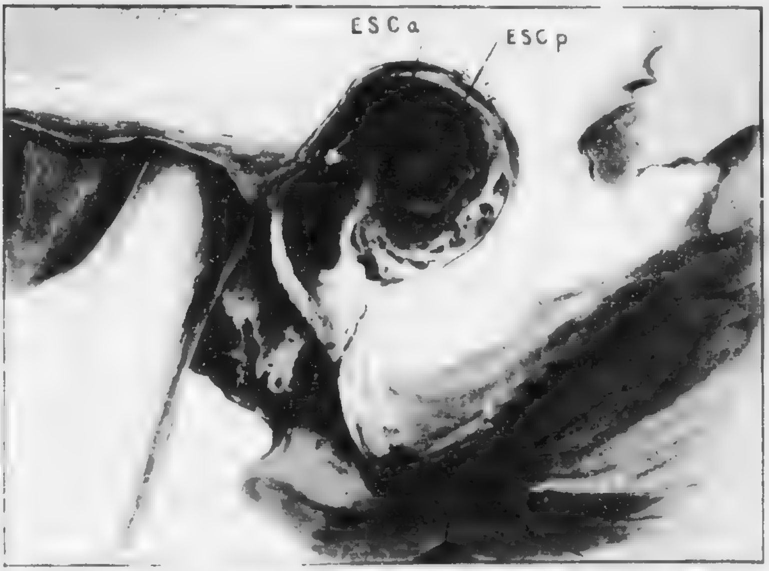


FIG. 69.—*ESCa* and *ESCp*. THE ANTERIOR AND POSTERIOR LIMBS OF THE EXTERNAL CANAL, WHICH ARE FOLLOWED UP INTO THE VESTIBULE.

Alternative Labyrinthine Operation.

If for any reason the labyrinth requires opening, whether it be for purposes of investigation or for the relief of symptoms due to suppuration within its cavities, in the cases where there is reason to apprehend the presence of cerebellar abscess, the following method (Neumann) is valuable: A preliminary mastoid operation being completed, the bone is cut away still more until the posterior fossa is opened; then proceeding forwards, the posterior canal is reached and cut away, thus opening the vestibule behind and below.

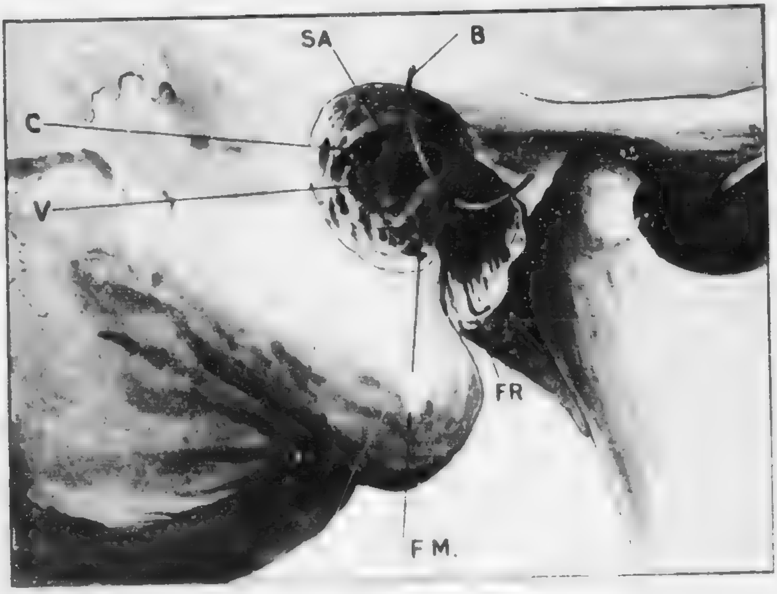


FIG. 70.—THE COMPLETED OPERATION.

B, Bristle passing through vestibule (*V*) and oval window; *SA*, ampulla of superior canal; *C*, cell; *FM*, bar of bone containing facial canal; *FR*, foramen rotundum.

Destruction or Ablation of the Cochlea.

This operation for the relief of tinnitus necessitates the complete destruction of the organ of hearing.

The preliminary steps of the operation will be found narrated on p. 230 *et seq.* The ear-flap described on p. 229 should be employed. Having then obtained a complete and full view of the middle ear, by cutting away the posterior wall as far as possible, so that the oval and round windows are clearly brought into view, and as much of the deeper portion of the inferior wall as is necessary to expose the lower part of the promontory, a straight gouge, not over $\frac{3}{16}$ inch wide, is taken, and whilst being rotated so as to describe a circle, with the most prominent part of the promontory as a centre, is continually struck sharply with the hammer or mallet. Care is taken to keep well away from the facial nerve, and to avoid the posterior inferior corner of the inner wall of the middle ear, as into this area a larger jugular bulb than usual may project, and its injury would, to say the least, complicate matters.

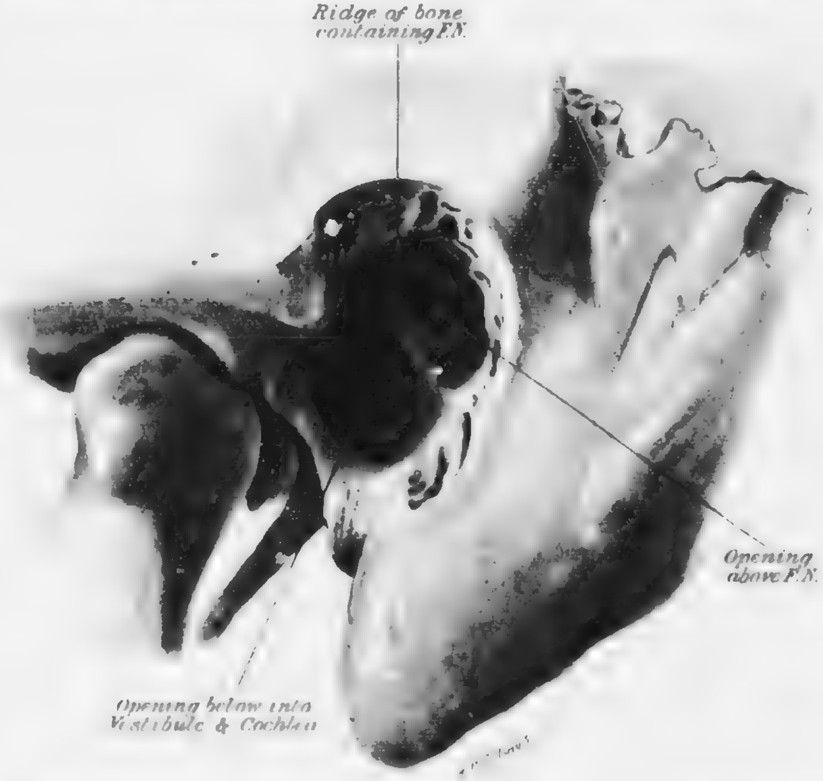

Ridge of bone containing F.N.
Opening above F.N.
Opening below into Vestibule & Cochlea

FIG. 71.—SHOWING OPENING OF COCHLEA IN TOTAL LABYRINTHECTOMY.

After a short time the bone enclosed within the gouge cuts becomes separated, and is removed, and the cochlea is freely opened. This free opening will extend into the vestibule, which later in the operation should be freely curetted. The contents of the cochlea are then scraped out, and a careful investigation with a small steel probe made to ascertain that the outer or lower turn is as freely opened and completely destroyed as the central and upper turns. The modiolus is now seen as a small projection on the floor of the cochlea, and may be removed by a simple blow of the chisel.

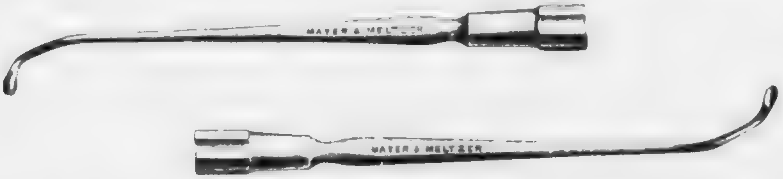


FIG. 72.—DOUBLE CURVED LABYRINTHINE CURETTE FOR CLEANING THE VESTIBULE AND AMPULLÆ.

This, however, opens up the subarachnoid space, and floods the wound with cerebro-spinal fluid, so the curettage of the vestibule should first be undertaken. When the modiolus is removed, a plug of sterilized beeswax is crushed through the opening until the flow ceases, as this does not always seem to occur without this precaution.

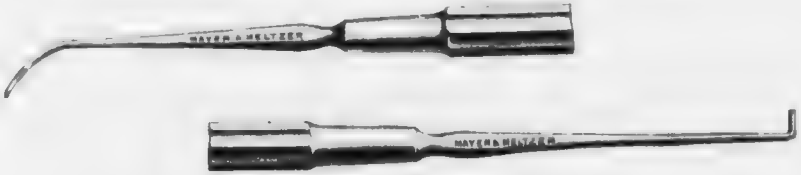


FIG. 73.—HOOK FOR ASCERTAINING DEPTH OF ANTRUM, AND SOFT IRON PROBE FOR TRACING SEMICIRCULAR CANALS.

A very large quantity of cerebro-spinal fluid may, of course, flow away without any ill-effects.

The toilet of the wound, as well as the after-treatment, are described under Mastoid Operations.

CHAPTER XIII

MALIGNANT DISEASE OF THE EAR

Malignant disease of the external ear may take the form of rodent ulcer, malignant warts, squamous-celled carcinoma or sarcoma. Malignant disease of the external auditory meatus takes the form of squamous-celled carcinoma or adeno-sarcoma.

Squamous-celled carcinoma may originate either in the form of an ulcer or a warty growth, rapidly breaking down, in either case the patients being usually past adult life and presenting themselves with a fœtid and usually sanious discharge from the ear, which will be accompanied by severe pain, though this is not always very pronounced in the earlier stages of the growth. Facial paralysis will often be an early symptom. On examining the external meatus, in the case of carcinoma, if there is no obvious growth, a sinus with foul edges may be seen in the wall of the meatus, from which the discharge exudes. An occasional early sign is fixation of the auricle. Besides the age of the patient and the suspicious appearance of the growth, the character of the discharge, the rapid incidence of a hectic appearance, and the presence of enlarged glands in the neck, will determine the diagnosis, which very rarely presents any great difficulties. In the later stages the rapid destruction or involvement of the surrounding parts, the formation of proliferating granulations, the profuse offensive sanious discharge, the appearance of the patient, the rapid emaciation, present so clear a picture of malignant disease that error is impossible.

Should the disease be of the adeno-carcinomatous variety, originating in the tissues of the external meatus, it will rapidly occlude the canal, with or without the formation of a malignant polypus bathed in a fœtid discharge.

At this time removal of the growth should be attempted, all anatomical landmarks being disregarded in attempting to obtain complete removal. If the middle ear be the seat of the disease, or if this originates in the surrounding bone, it may be of a myxo-sarcomatous nature, which occurs in early childhood, sarcomatous or carcinomatous, the temporal bone in either case becoming rapidly involved; and the condition may be one which resembles that of an early acute mastoiditis, though the age of the patient with cancerous disease is often later than that at which acute mastoiditis is found; yet a large number of malignant cases occur in early adult life, and at the same time the absence of any history of suppuration or of illness suggesting influenza, and the general condition of the patient, together with a careful examination of the deeper parts of the meatus, will usually enable the surgeon to recognize the serious disease which is present, and prevent him from making an error in diagnosis. It is but rarely that suppurative disease of the middle ear is followed by malignant disease. The history of a case of malignant disease will usually be that the patient has suffered a considerable time from pain and a certain amount of discomfort in the mastoid bone and surrounding parts, that a more or less diffuse swelling has made its appearance behind the ear, which has gradually increased, together with the existence of glandular infection.

It is hopeless to attempt the removal of malignant disease starting in the deeper parts of the temporal bone, so that the surgeon's efforts must be directed towards obtaining euthanasia.

CHAPTER XIV

OTOSCLEROSIS

Otosclerosis, like the adhesive catarrh, is a progressive subinflammatory affection. Its etiology at the present time is not clearly determined, but in a very large number of instances at least it is concomitant to and part of a general sclerosis of the submucous tissues of the whole respiratory tract, of which the Eustachian tube and middle ear are diverticula. This pathological condition is frequently influenced by, or is dependent on, hereditary syphilis, while heredity itself, apart from the specific taint, exercises a baneful influence upon cases of this description. The sclerotic condition alluded to commences at the orifice of the respiratory tract—that is to say, at the anterior nares—and on examination of the nasal chambers by anterior rhinoscopy the mucosa presents appearances characteristic of rhinitis sicca. The condition extends into the naso-pharynx and down the posterior wall of the oro-pharynx, and is said to extend as far as the submucous tissue of the finest ramifications of the bronchi. At first sight the nose may be described as looking healthy, but closer inspection shows the mucous membrane abnormally red and dry, while the patients rarely, if ever, suffer from nasal catarrh, or require to use a handkerchief. In mixed cases various forms of nasal obstruction are found, as in adhesive otitis media. Atrophic rhinitis and atrophic naso-pharyngitis are frequently associated with deafness caused by otosclerosis. In the ear itself the earliest condition known is muco-periostitis of the inner wall of the tympanum, which may be recognized by the presence of a pinkish blush or reflex in the region of the promontory or oval window, and seen through the unthickened tympanic membrane behind the handle of the malleus, higher or lower according to circumstances. This periostitis may occur without known cause or may follow an acute otitis media (Plate IV., Figs. 10 and 11).

The pathological observations on record, from which we are able to arrive at a knowledge of the morbid changes which occur during the progress of the disease, mostly deal with cases in which the disease has already attained some degree of severity. They show two distinct changes, one class being the development of patches of osteoporosis or rarefaction, which are found in various parts of the labyrinthine capsule—viz., in the promontory, in the neighbourhood of the fenestræ, and in the modiolus of the cochlea. The other series of changes consist in the formation of osteophytes in the environment of the oval window, both intratympanic and intralabyrinthine, the intratympanic osteophytes causing fixation of the stapes, while the intralabyrinthine osteophytes will directly affect the intralabyrinthine space, and thus materially interfere with the auditory function. Besides this, ossification of the annular ligament around the footplate of the stapes takes place in the later pathological state. This is followed or accompanied by atrophy of the organ of Corti.

In advanced stages of the disease, the labyrinthine fluids diminish in quantity, and finally become practically non-existent, though it is doubtful whether this condition is one entirely restricted to this disease, or does not also occur in severe nerve-deafness due to arterio-sclerosis.

The disease is found even in early childhood, but appears more frequently in young adult life, especially in anæmic females.

Course and Symptoms.—The onset of the disease is usually gradual, but may be comparatively rapid. It may steadily progress or may be intermittent, and, again, may remain stationary for a long period of years, this period of rest being usually followed by a sudden increase in deafness. No known cause appears to influence its progress. When the disease occurs in children, it is frequently accompanied by the presence of adenoid vegetations in the naso-pharynx, and it is due to this early condition of otosclerosis that in a considerable number of cases the removal of adenoid vegetations for deafness is not followed by any improvement in hearing. The disease is sometimes unilateral at its commencement, but more usually bilateral, and it rarely remains one-sided for any length of time.

The chief symptom is deafness, tending to increase, and remarkably uninfluenced by inflation of the middle ear. Tinnitus usually is an early symptom, and may be complained of before deafness is noticed It increases in severity with the progress of the disease, and becomes an intolerable annoyance and a source of grave discomfort to the patient, more so, in fact, than is common in any other form of middle-ear disease. It naturally influences most those patients whose habits of life or temperament render them more liable to nervous disturbance. As distinguished from the noises complained of in adhesive disease of the middle ear and other external and middle-ear disorders, patients suffering from otosclerosis frequently refer them to the head rather than to the ear.

As subsidiary symptoms, a feeling of dulness, or occasional pain and aching in the ear, may be complained of, especially in the earlier stages.

Patients suffering with non-suppurative middle-ear trouble, even though it be slight, will occasionally complain of the most agonizing pain in the mastoid. This pain will not only be complained of, but may *apparently* be elicited by pressure, and the patients themselves will beg for operative relief ; but in such cases a compliance with their request is unsurgical and useless, only serving to fix more firmly in their minds the fact that they are suffering from a disease of the bone, the lines of treatment which must be adopted in such cases being counter-irritation, especially at some slight distance from the part—as, for instance, the nape of the neck—the administration of valerian and tonics, healthy living, and, if necessary, high-frequency treatment. And as it is possibly an intracranial neuralgia of a branch of the fifth nerve, injections of alcohol into the Gasserian ganglion might be tried.

Deafness, like that of other middle-ear diseases, is more noticeable at first in general conversation, but musical sounds are not usually perverted. Paracusis Willisii is a more frequent symptom than in adhesive catarrh, being due to the frequency with which the stapes is fixed. Finally a form of Menière's disease is found at times as a complication.

Tuning-Fork Tests.—In primary disease of the labyrinthine capsule, with the presence of rarefying osteitis, Rinne is negative, with increased bone-conduction, though diminished bone-conduction may be present (Proportional Test δ and ζ). Air-conduction will be diminished in all cases. If new bone should be thrown out within the cochlea, or if the disease be complicated by secondary internal ear lesions, bone-conduction will be diminished. It is well to know that Rinne's test, which is negative in this disease, may be either total or partial. By total is meant that, if a tuning-fork of a pitch below C^1, as well as a fork of higher pitch, is employed, the result will be negative in both cases; but if it is partial, the higher-pitched tuning-fork will give a positive result. Gellé's test is valuable in demonstrating the fixation of the stapes—that is to say, if Rinne's test is negative up to and including C^2, and Gellé's is also negative, then the stapes is ankylosed. If Rinne's is negative below C and positive above, Gellé's test again decides the question as to whether the stapes is ankylosed or not. Air-conduction in advanced cases to all the lower forks is lost—*i.e.*, those of sixteen, thirty-two, and sixty-four vibrations per second—the lower tone limit ascending with the progress of the disease.

The condition of the membrana tympani in uncomplicated cases is markedly different from the condition observed in adhesive catarrh. There is little, if any, retraction of the membrane, which is more translucent than normal, the subjacent structures and contents of the cavum tympani being frequently distinguishable to a greater or less extent, and at the earlier stages, as previously noted, there is occasionally a pinkish blush over the promontory. When, however, otosclerosis is complicated with adhesive catarrh, the membrane may present any appearance between the two extremes. The external meatus is often singularly devoid of cerumen, pale in appearance, with a tendency to exhibit a polished surface, and not infrequently it appears rather larger in calibre than normal. This is due to an extension of the disease to the subepithelial tissues of the external meatus. Fixation of the handle of the malleus is only found in cases of otosclerosis when complicated with chronic catarrhal otitis media.

The fact has already been stated that, in a large number of cases of otosclerosis, the nasal passages are unusually free, and present the signs of rhinitis sicca ; however, where this condition of the nose does not exist, and where there is a certain amount of nasal obstruction, the same patency of the Eustachian tubes is present. This fact is of great diagnostic value. The tubes are abnormally free ; on inflation with a catheter or with Politzer's bag, the air is heard to rush into the middle ear with a large stream and without any hindrance, also rarely with any relief of the deafness ; if the disease is of any duration, patients not infrequently state that they only hear, but do not feel, the air entering the cavum tympani.

PROGNOSIS.—This is very unfavourable. In a certain number of cases the morbid processes remain stationary for a long period of time, though the general tendency of the disorder is to become markedly worse ; careful treatment will no doubt enable the surgeon in a large number of instances to obtain a certain amount of relief, or, at least, to retard the march of the disease.

TREATMENT.—First, with regard to the use of the Eustachian catheter and inflation in uncomplicated cases. This method of treatment will not only be unattended by any benefit, but occasionally *appears* to be followed by a temporary increase of deafness. When, however, the case is one of mixed otosclerosis and adhesive otitis media, the use of the catheter may be productive of a slight improvement.

The use of injections of various sorts is occasionally productive of good. Those most to be recommended are: Odourless paraffin ; ½ per cent. iodine in the same oil ; solutions of iodide of potassium, 5 grains to the ounce. The fluid ointment (*vide* Appendix 38) is the most valuable of all. These drops should be introduced into the catheter and blown into the middle ear thrice a week, or oftener, for several weeks (about six).

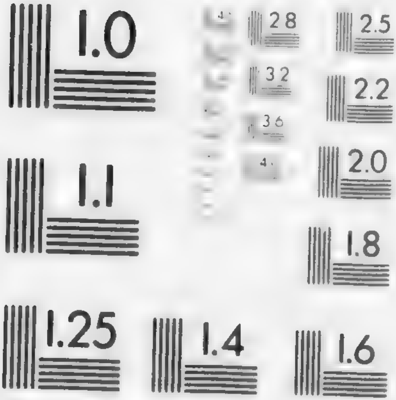
Of other local measures, oto-massage is always to be practised, unless after the first application it is attended by a diminution in the hearing-power. It should be employed daily, commencing with a period of about half a minute, which may be gradually increased to three minutes, per diem.

Of the two factors in pneumo-massage, rapidity of the vibrations and the strength of the pull, the latter is the less important. A light pull should be employed, which means that the stroke of the piston is short, but a high number of revolutions per second made use of.

The administration of internal remedies is worthy of trial even in pure cases of otosclerosis. If the case, however, is one in which this disease is combined with adhesive otitis media (non-suppurative), oto-massage is likely to increase the good effects derived from these remedies. Good may result from the administration of phosphorus. This should be administered with caution and in an oily solution ($\frac{1}{10}$ per cent. in oil or mistura amygdalæ), and be given three times a day after food, commencing with 10 minims, and gradually increasing the dose to 45 minims. If, however, stomachic disturbances are produced, the drug should be given in keratin or glutin capsules. Besides this, one has the following remedies. Strychnia in full doses. Iodide of potassium, which should be administered in doses of 3 to 5 grains in ½ pint of hot water directly after meals. In anæmic cases the syrup of the iodide of iron may be substituted for the potassium salt with advantage. When mercury is administered, as it always should be if there is the least suspicion of inherited syphilis, it may be given as the perchloride or biniodide—the latter in the form of a pill, the former in combination with cinchona (*vide* Appendix). In the latter prescription it will be found that the two may be combined without any deposit being formed.

MICROCOPY RESOLUTION TEST CHART

ANSI and ISO TEST CHART No. 2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APPLIED IMAGE Inc

OTALGIA.—On p. 37 we have already reviewed to a large extent the causes of otalgia, and where this has been referred to under the diseases in which oral pain forms part, the treatment has to a large extent been considered. But occasionally patients come complaining only of ear pain, a real neuralgia of the great auricular or of the posterior auricular branch of the facial. This pain, when unassociated with other neuralgias often comes, as I have said, under the hands of the specialist. It is an extremely difficult matter to effect a cure, but as we have stated elsewhere (p. 240), under no conditions whatever should the surgeon be tempted to operate on the mastoid, but he should, if possible, find out the exact spot at which the nerve courses cover the posterior edge of the mastoid process. This is comparatively easily done during an attack of pain, when by means of one's finger-nail the exact spot is easily located. This having been marked, 10 to 15 minims of absolute alcohol should be injected into the nerve, or as nearly as one can arrive at it. The beneficial effect of this treatment is extremely marked, provided the injection is made with the greatest care as to direction.

OPERATIVE TREATMENT OF TINNITUS.—Mobilization of the stapes, trephining of the promontory, excision of the tympanic membrane and ossicles, and the radical mastoid operation, have all had their advocates, as has also the extraction of the stapes. Unfortunately, the results of none of these operations justify their being recommended for adoption. But when the tinnitus is really distressing, ablation of the cochlea is quite justifiable, and may prove successful—*i.e.*, when the tinnitus is aural and not central.

CHAPTER XV

DISEASES OF THE INTERNAL EAR

General Therapeutics of Internal Ear Diseases (Non-Suppurative).

Physiological Rest.—The advantages which can be derived from complete physiological rest in cases of early deafness, especially when there is reason to believe that the labyrinth is already slightly affected, are not to be neglected. It should, indeed, almost be considered as part of the routine treatment of most cases of deafness. Especially is it valuable in mild or early cases.

We propose several means of obtaining this physiological rest. No doubt the best means to employ is to send one's patient to some quiet locality, either to some fishing village on the coast, especially where the shore is sandy, such as the East Coast, or to some secluded place, well wooded, where the patient can be away from all sounds, especially those of the human voice and the rumble and turmoil of traffic.

Where this is not to be obtained, one ear can be occluded largely during the day on alternate days if both ears are affected, and both must be occluded at night by means of plugs inserted in the ear, either making use of the rubber sound deadener, or of shooters' wax, or some similar preparation. There is no doubt that part of the good effects usually observed in patients who have spent some weeks in mountainous districts owe part of their improvement to the absence of noises in these regions. Particularly should the use of the telephone be prohibited in all cases of early deafness of the middle and internal ear, as the concentration of sound and the concentration necessary for the receiving of messages can have no other but a deleterious effect. It seems also probable that frequent nose-blowing, by acting, as it were, as a chronic concussion to the labyrinth, is also a thing to be avoided, especially if there is any rigidity of the tympanic membrane and immobility of the malleus.

Injuries to the Internal Ear and Auditory Nerve.

Direct injury to the internal ear can only arise from long and fine articles being thrust through the drum, and chancing to pass through it in such a direction that it drives inwards the plate of the stapes, and penetrates into the vestibule. One such case is, indeed, upon record. The symptoms would be pain, severe and prolonged vertigo, with probably diminished hearing, and unless the instrument was absolutely clean, these would be followed by the symptoms of suppurative labyrinthitis Indirect traumatic effects are concussion of the labyrinth, and the passage of the line of fracture in fracture of the cranial base through the labyrinth.

Concussion of the labyrinth may be gradually produced or suddenly. In the former instance it will be by the effect of oftentimes repeated loud and more or less sudden noise, as in battue shooting with nitro powders; in artillery practice, chiefly with machine or quick-firing guns; or as is found in certain occupations, as boiler-makers and riveters. Nor is it certain that frequent and vigorous self-inflation of a rigid tympanum will not produce a similar result. In the latter concussion of the brain may be accompanied by concussion of the labyrinth, or a blow over the ear may have a like effect, with or without injury to the tympanic membrane.

Symptoms.—The least severe cases of sudden concussion are followed by a constant and usually permanent tinnitus, whilst to the more severe will be added deafness.

In the cases of gradual concussion tinnitus and deafness, or deafness with little tinnitus, are complained of. On testing these patients, one finds Rinne α or Rinne ϵ in the majority of cases, and whispered words are relatively well heard in the mild cases, and in boiler-makers paracusis Willisii is noticed. When the injury is the result of a fracture, deafness is invariably noted, but is not always permanent. A recovery in some instances must be attributed to the deafness being produced by the concussion, and not by direct injury to the cochlea or auditory nerve, and probably in these cases the line of fracture will be visible in the external meatus.

In those cases where the line of fracture passes through the cochlea deafness is immediate and complete. Vertigo is not often noted, as the condition of the patient does not permit of its discovery ; indeed, it is often that the deafness is only discovered during convalescence. Tinnitus is loud and very distressing. The patient often has no aerial perception of tuning-fork sounds, but C^1 to C^3 are those last preserved.

The PROGNOSIS in all these lesions is bad.

TREATMENT is not satisfactory in concussion or injury until after the acute inflammatory reaction has passed. Liq. hydrarg. perchloridi is the most useful drug. In what one may term the chronic forms of concussion reliance must be placed on strychnine or iodide of potash.

Diseases of the Internal Ear.

The internal ear consists of the membranous labyrinth, the cochlea, vestibule, and semicircular canals, which receive the terminations of the auditory nerve ; in diseases of the internal ear are included those of the auditory nerve itself. The auditory impressions are received by the cochlea, while the semicircular canals are largely concerned in the maintenance of equilibrium. We detect disease of the cochlea, as distinguished from diseases which prevent sound-waves from reaching and from stimulating the nerve-endings of that part of the auditory nerve which supplies the cochlea, by means of the various sound-testing investigations. These have already been described in the chapter on Examination of the Ear. The more important diagnostic tests for internal-ear deafness are, when the hearing-power for speech is greatly reduced : In early cases material diminution or complete absence of bone-conduction for Politzer's acoumeter or the watch ; loss of high tones, as shown by Galton's whistle ; diminution of or loss of bone-conduction for tuning-forks, especially those of high pitch; Rinne's test is positive, but at the same time there is a shortened perception for the tones of the tuning-fork, and if the deafness is one-sided the fork in Weber's test is referred to the sound side. The ear is easily fatigued by testing, and hearing is worse in a noise, and at times better in the open air in quiet places than indoors. The Eustachian tube will be patent, inflation of the middle ear will give no improvement, and there may be no pathological changes in the middle ear. But the difficulty of demonstrating conclusively a case to be one of internal-ear deafness is materially lessened by negative evidence of middle-ear trouble. Instances of nerve lesions occur which show hyperacoustica of bone-conduction.

Diseases which affect the internal ear are either primary or secondary, the former being much the more rare. They may consist in hæmorrhages and in primary inflammations; whilst as secondary affections may be taken traumatism in all its forms, and the effects of general diseases, such as syphilis, rheumatism, gout, malaria, leucocythæmia, etc. But of all the causes acting on the internal ear, the most prolific are diseases of the middle ear, together with otosclerosis, which, although usually placed for convenience amongst the diseases of the middle ear, affects at least equally the internal ear. Certain toxic agents distinctly affect the auditory nerve, such as quinine, the salicylates, opium, tobacco, and alcohol. The specific fevers, especially typhoid fever, mumps, influenza, diphtheria, and cerebro-spinal meningitis, may be the cause of acute labyrinthine changes, causing sudden and permanent deafness.

Hyperacousis Nervosa.—Hyperacousis is usually found (as otalgia) in females, and is rarely noticed, except when there is some slight affection of the auditory nerve. It is usually intense sounds which cause the painful impression, as well as sounds of high pitch, yet any loud noise or sound will produce the same effect irrespective of pitch. It is very rare, however, to find hyperacousis as a solitary symptom, but it is usually accompanied by other manifestations of a general instability of the nervous system, and for this reason these cases lie, for the most part, in the province of the general physician or neurologist.

They are extremely difficult to handle, but while the general treatment suitable to the general condition is employed, hyoscyamin will be found an extremely valuable drug for the relief of the special symptom ; so also will valerian in large doses.

Syphilis of the Internal Ear.—Acquired syphilis comparatively rarely affects the organ of hearing, but may do so both in the secondary and tertiary stages. In the former there is a general hyperæmia of the mucous membranes, which will invariably rapidly yield to treatment, and the deafness soon pass away, and requires no treatment directed towards the internal ear itself. In the tertiary stage, the acquired disease will cause a mixed otosclerosis and labyrinthitis with severe deafness and Menière's symptoms.

Hereditary syphilis, also, is a frequent cause of internal-ear disease. Here the period of onset is in early adult life, usually shortly after, or even during the progress of, an attack of interstitial keratitis, and it may be that the patient is even at that time being treated with antisyphilitic remedies. The progress of the disease is one of extreme rapidity, being bilateral and very intractable. Sometimes at the end of a week, or even less, the patient is absolutely deaf. Our treatment must in consequence be equally vigorous, and while mercury should not be discontinued, iodide of potash must be given, and is best administered in 5-grain doses in hot water after meals. Besides these specific remedies, pilocarpine should be employed ; nor should this be delayed to observe the result of our other treatment. It should be administered in the form of hypodermic injections, commencing with $\frac{1}{20}$ grain injected under the skin over the mastoid process on either side on alternate days increasing the dose rapidly up to $\frac{1}{5}$ grain, which should be considered the largest dose from which benefit is likely to be derived. On account of the profuse perspiration which is set up by this drug, the patient should be confined to the house during the treatment. If the patient be anæmic, tartrate of iron and bark should be combined with the antisyphilitic drugs. When pilocarpine treatment is not of any benefit at the expiration of three weeks, it should be discontinued ; otherwise it may be persisted in as long as improvement is noticed. Strychnine, the dose of which should be rapidly increased, should be tried if other drugs fail. The steady increase of the strength of the dose will usually enable the patient to acquire a tolerance for the drug, which may be increased to 12 minims of the liq. strych. thrice daily. But whatever treatment is adopted, it must be recognized that the great majority of cases will not show any improvement in acquired tertiary disease of the labyrinth. Iodoform (in pills of 3 grains) will sometimes succeed where iodides fail, and the same applies to the more recent organic iodine compounds. Salvarsan is not to be recommended for aural cases, as its local effect is often most injurious.

Gout.—Gouty disturbances of the internal ear are more frequently connected with subjective noises than with deafness, unless it is combined with chronic non-suppurative disease, and it may then be, and frequently is, accompanied by severe attacks of vertigo, which are, though partly due to the auditory trouble, accentuated by the general dyscrasia. In considering any particular case, one must give due weight to any organic disturbances present, such as a large and flabby heart. But, while giving due attention to the gastric or circulatory disturbances, it will be desirable at the same time to employ such remedies as will lessen the aural trouble. These will consist in counter-irritation behind the ear, either by the action of blisters or rubefacients. If the latter are employed, the skin should be made tender, but vesication avoided ; whilst the internal administration of antilithics together with alkaline nose-washes should be ordered, and the nasopharynx regularly kept painted with Mandl's solution (see Appendix).

Anæmia.—A deficient supply of oxygen in the blood causes frequently a diminution in the functional activity of the cochlea, in common with the like effect experienced by the other organs of the body, and with this anæmic condition of the labyrinth is closely associated those forms of *functional* or *hysterical* deafness. It is, however, necessary in anæmic cases to be particularly careful as to how much direct treatment is adopted towards the auditory nerve. In these cases the tuning-fork tests, which show most erratic results often with loss of hearing-power for certain tones, will convince one immediately that the disease is of neurotic origin, the patient being able to hear a certain amount of conversation, especially if the questions asked are relevant and in a low, clear voice; whilst the tuning-fork may not be heard at all if applied to the mastoid, and any other sound test will be pronounced inaudible.

In these cases, besides any general treatment, such as the administration of arsenic and iron, a mild counter-irritation behind the ear will be extremely useful, but the use of the catheter or politzerization is absolutely contra-indicated until such time as the patient's nervous system is more under control. In order to obtain this result there is no more valuable remedy than valerian, and, as its nauseous taste has no therapeutic advantage, it may be administered in the form given in the Appendix.

Malaria.—In acute attacks of malaria marked deafness is often a prominent and well-marked symptom. This, however, is frequently due to a large extent to the excessive administration of quinine. When this is the case, if the internal ear be not immediately affected by the disease itself, complete recovery of the hearing will follow the cessation of the exhibition of quinine. In other instances, even when no quinine has been administered, a marked residual deafness remains, and in these a characteristic reaction of the tuning-fork test will be noted; that is to say, there is a great reduction in the length of bone-conduction compared with the aerial conduction.

This condition will generally rapidly yield to regular catheterization, together with the internal administration of strychnine and arsenic. The strychnine should be administered, as in other cases of ear-deafness, in rapidly increasing doses.

This form of deafness is probably due to the changes which take place in the blood in malarial affections.

Increase of Labyrinthine Pressure.—An increase of intralabyrinthine pressure causes a disturbance of hearing if it occurs in the cochlea, and of equilibrium if it occurs in the semicircular canals.

Causation.—Increased labyrinthine pressure may occur during the course of any of the exanthemata, typhoid fever, mumps, pneumonia, and meningitis. It may be the result of a sudden effusion of fluid without any well-determined cause, or, especially in middle-aged and elderly people, from the effect of sudden cold, gout, or Bright's disease; or be caused by sudden driving in of the stapes by rapid raising of the atmospheric pressure in the external meatus, as when working

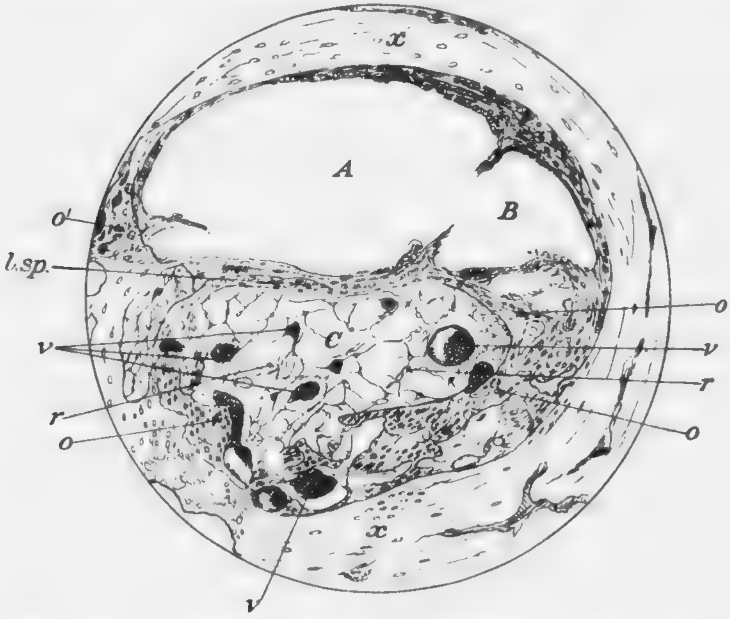

FIG. 74.—LEUKÆMIA: SECTION OF COCHLEA, LOWEST PART.

A, Scala vestibuli; *B*, canalis cochlea; *C*, scala tympani; *r*, delicate reticulum (organized clot) in scala tympani, containing numerous thin-walled bloodvessels (*v*); *o*, newly formed bone in scala tympani; *o*^{1}, newly formed bone in scala vestibuli; *x*, normal bone; *l.sp.*, lamina spiralis.

in compressed air. Those cases known as aural epilepsy come under this category.

Symptoms.—Deafness, coming on during any acute illness, will often not be recognized until the acute symptoms of the general disorder have subsided. When, however, it occurs in comparative health, the patient will suddenly lose the hearing of one or both ears, very frequently at night. Vertigo is a common symptom, though it is frequently transient in character. The tuning-fork, even when vibrating strongly, will either be not heard at all, or only barely perceived by bone- or air-conduction.

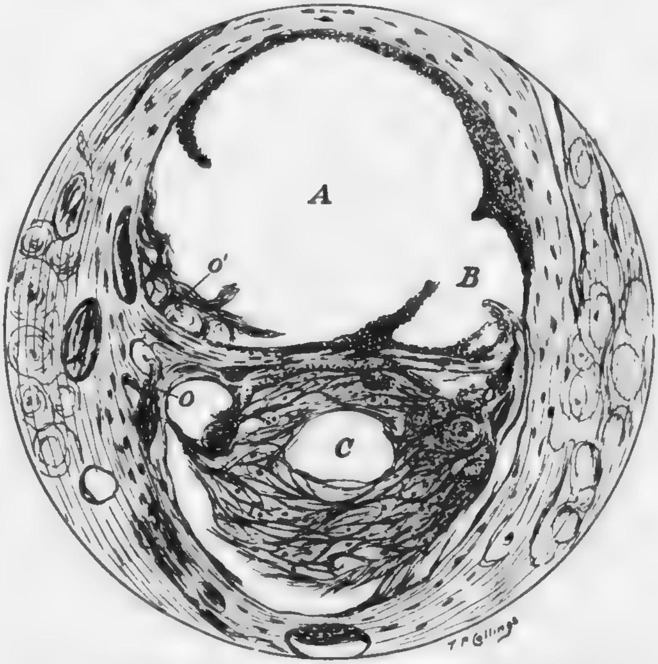

FIG. 75.—SECTION OF COCHLEA, HIGHER UP THAN FIG. 74.

A, Scala vestibuli; *B*, canalis cochlea; *C*, scala tympani; *o* and *o*^{1}, new bone-formation.

Subjective symptoms are occasionally present, and are very distressing.

Treatment.—In this class of case, the hypodermic injection of pilocarpine, as recommended on p. 249, should be employed. For the relief of tinnitus, hydrobromic acid (doses of ʒi.), conium, valerian, and strychnine, are the more useful remedies, while vesication or counter-irritation over the mastoid are useful aids.

Aural Vertigo, as distinguished from vertigo arising from diseases of other parts of the system, may be defined as a vertigo associated with an obvious lesion of the labyrinth (certainly of its posterior portion, and also almost invariably of its anterior or auditory part).

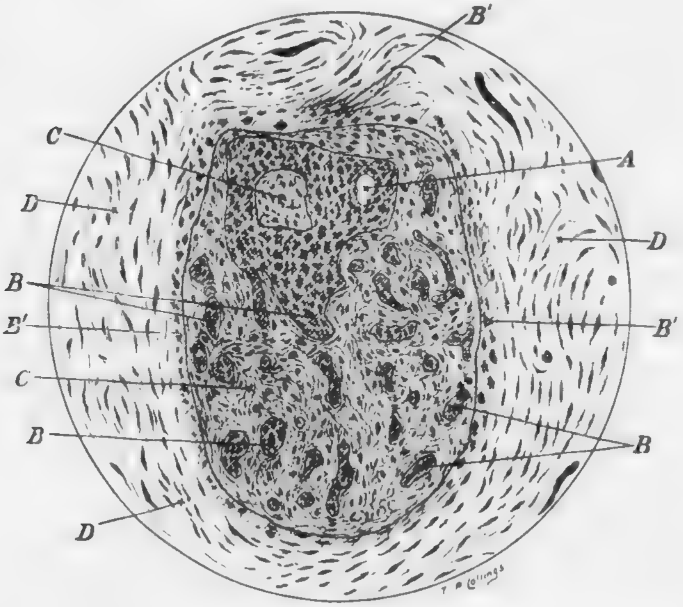

FIG. 76.—SECTION THROUGH HORIZONTAL SEMICIRCULAR CANAL.

A, Membranous semicircular canal; the perilymphatic space is completely obliterated by new bone (*B*) and newly-formed fibrous tissue (*C*); B^1, new bone-formation beneath endosteum; *D*, normal bone.

This vertigo may occur when the aural disease is apparently confined to the conveying or to the perceptive portions of the aural mechanism, but true aural vertigo, arising in the ear itself, is always accompanied by deafness more or less severe.

Aural vertigo arises from the following causes:

1. Intralabyrinthine hæmorrhage
2. Leukæmic infarcts and exudations.
3. Increase of intralabyrinthine pressure.
4. Great diminution of intralabyrinthine fluid.
5. Bright lights and noises.

The most frequent causes of vertigo which may be mistaken for aural vertigo are flatulent dyspepsia, circulatory disturbances, and neurasthenia. In these cases, when there is any disturbance of audition, it is recovered from after the attack.

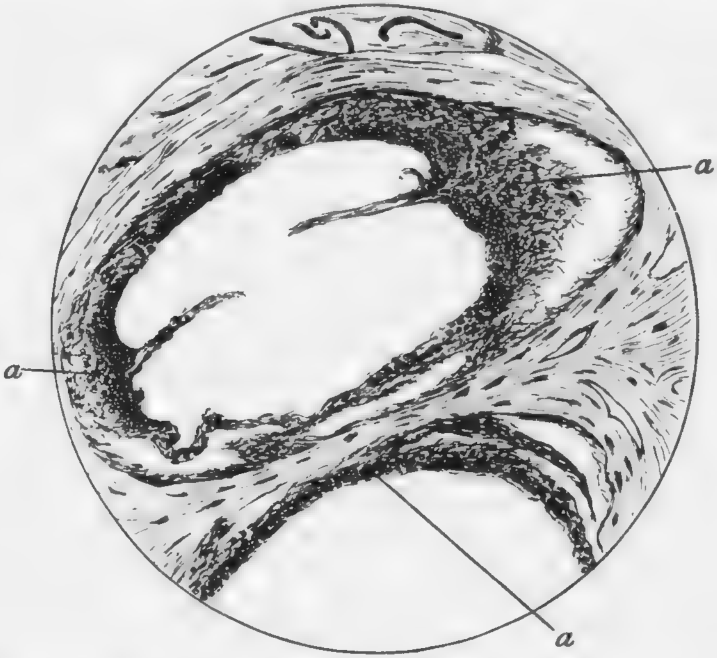

FIG. 77.—SECTION OF APEX OF COCHLEA, SHOWING LEUKÆMIA CLOT COMMENCING TO ORGANIZE.

Finally, there is a vertigo due to a disturbance of the circulation of the nucleus of the vestibular portion of the eighth nerve. In these cases arterio-sclerosis is the active factor, and an increased blood-pressure combined usually with overwork.

1. VERTIGO DUE TO HÆMORRHAGE INTO THE LABYRINTH.—This is a rare condition, and is due to the rupture of an arteriole of the vestibule, and forms the great exception to the general rule of disturbance of hearing accompanying aural vertigo, for if a hæmorrhage is small in amount the damage is local, and that division of the labyrinth alone is affected in which the lesion exists. The original cause is arteriosclerosis. The attack is rarely repeated, but leaves a permanent injury, as may at times be evidenced by a prolonged want of co-ordination, and later by evidence of want of irritability, as shown by the rotation and calorific tests.

2. LEUKÆMIC HÆMORRHAGES AND INFARCTS.—The condition now under consideration is known as Menière's disease. Custom and carelessness of diction has grouped all cases of aural vertigo, when combined with deafness and tinnitus, as Menière's disease, but if the term is to be retained, it should be restricted to these leukæmic cases. Naturally, one only finds this form in persons suffering from one or other of the leukæmic states of the blood.

The infarcts into the internal ear are usually bilateral. They occur without previous warning, and are accompanied by or cause severe vertigo and nystagmus, occasional loss of consciousness, sickness, vomiting, and deafness, more or less complete. Of these symptoms, two gradually disappear—first the vertigo, then the tinnitus—but the hearing power is not recovered.

The hæmorrhage takes place within the lymphatic sac, either filling or compressing the membranous labyrinth with clot.

This clot, formed principally of white corpuscles, becomes organized if the patient survives, as is frequently the case. The whole clot becomes ossified. Sometimes so extensive is this ossification that the membranous semicircular canals are represented by the physiological canal alone (Fig. 76), whilst in the cochlea the organ of Corti, together with the membrane of Reissner, may be converted into bone, and the various scala remain filled with organized clot.

It is quite obvious that no treatment is available for the auditory trouble.

3. Increase of Intralabyrinthine Pressure.—There is but little direct evidence as to excess of intratympanic fluids, but cases occur in the exanthemata, mumps, meningitis, etc., which are probably due to some temporary increase in pressure. Caisson workers suffer from vertigo if the air-pressure is increased too rapidly, the stapes being forced inward, and thus the intratympanic tension is momentarily increased. Again, those cases of vertigo which have been classed under the heading of aural epilepsy sometimes have labyrinths unusually large, and containing far above the average amount of intralabyrinthine fluid, though whether this is a cause in itself or merely a predisposing cause there is no evidence to show.

4. Vertigo due to Diminution or Absence of Intralabyrinthine Fluids.—This form is always combined with deafness. Frequently the deafness is of long standing, the vertigo appearing as a later symptom, rarely, however, before the age of forty. The attacks sometimes increase in frequency and violence, producing agarophobia, or if not, remaining apparently about a constant frequency, may eventually disappear. This happy consummation is, however, rare, and one cannot state with any probability what length of time must elapse before it occurs, nor is it easy to foretell in which cases the vertigo will cease. The best aid to prognosis is when the intervals between attacks steadily increase, whilst there is a corresponding diminution in the severity of the attacks.

The arterial tension will be high in these cases.

Treatment.—The drugs which are of value are the iodides and hydrobromic acid, which may be exhibited as for arteriosclerosis generally. Beyond this, quiet and care must be enjoined. No local treatment short of operation is likely to be of any avail.

5. Vertigo caused by Bright Lights and Noises.—These would at first sight appear to be of neurotic origin, but in reality are not so, but owe their existence to some obscure cerebral condition.

Treatment.—In the former, a most searching ophthalmic examination should be insisted on, and any irregularities of vision corrected. In the latter, some form of sound deadener should be employed as constantly as possible, and valerian and bromide administered.

Non-Aural Vertigos simulating Aural Vertigo—VERTIGO OF CENTRAL ORIGIN, OR VERTIGO ARISING FROM CAUSES REACTING ON THE CENTRAL NUCLEUS OF THE EIGHTH NERVE.—A condition readily confused with a peripheral vertigo, and inasmuch as the patient is most likely to seek advice for aural trouble, it is well to allude briefly to the salient points.

Like all conditions principally due to arterio-sclerosis, early morning is the principal time of the attacks. The attacks are always traceable to over-strain or over-exertion. They are transitory, and without any marked increase of deafness, or if that coexists, there is no obvious connection between the vertiginous attacks and the loss of hearing; and when appropriate treatment is adopted, the hearing power improves and the vertigo disappears.

VERTIGO OF GOUTY AND DYSPEPTIC ORIGIN.—In this class of case, apart from signs of dyspepsia and symptoms of gout, it will be found that during the vertigo there is marked deafness, which is transient, clearing up rapidly after the attack.

VERTIGO FROM DIMINISHED ARTERIAL TENSION.—These patients have often a deaf ear, and, apart from one symptom —*i.e.*, excessive vertigo—on rotation one finds it difficult to describe specific signs for its detection, but diminution of the blood-pressure during and after the attacks is characteristic.

TREATMENT.—For the apoplectiform variety no special treatment devoted to the ear is of any avail. In the progressive form, hydrobromic acid, iodide of potassium, arsenic, and, later, quinine, either in large or small doses (Appendix), are the more serviceable internal remedies, though if there be much nervous excitability the bromides will be superior. The effect of pilocarpine may also be tried. The only local treatment which appears to have any beneficial effect is the use of the constant or high-frequency current, one pole being placed over the mastoid process and the other at the back of the neck. Very weak currents should be employed at the commencement, and the sitting should be of short duration, but should be repeated daily. This should not be employed at the commencement of the disease.

Operation will in all but cases of central origin cure this condition. All forms of treatment failing, recourse may be had to operation. The essential is that the vertigo be of aural, and not general or central origin. The same operation is performed as in suppurative labyrinthitis. The results are most excellent, and the patient is quickly relieved of his trouble, and when the patient's livelihood or general comfort is considered, no hesitation need be felt in recommending vestibulotomy.

Inflammation of the Labyrinth, or Otitis Interna.—This condition, most frequently a complication of suppurative disease of the middle ear, may be secondary to tuberculous meningitis. Trauma is responsible for a certain number of cases when fracture of the base of the skull has extended from the labyrinth, and suppuration has followed ; also a case has been reported in which septic disease of the labyrinth followed an injury, a needle being pushed through the membrana tympani, and driving the footplate of the stapes into the vestibule.

The condition may itself be followed by general sepsis, meningitis, extradural abscess, sinus pyæmia, or brain abscess —usually cerebellar. In other instances it will be followed by necrosis of the labyrinthine capsule, a condition which has already been alluded to as a sequel of suppuration in the middle ear.

The symptoms will usually be ushered in with high fever, though in chronic cases the temperature is not raised, with intense vertigo, a tendency to fall towards the side affected, or it may be to the sound side, nystagmus, and vomiting, absolute deafness when the cochlea is involved, these symptoms being frequently accompanied by a severe tinnitus. In acute cases the attitude of the patient will be that of cerebral irritation. The vertigo is a transitory symptom, but the tinnitus is apt to remain. This condition was first described early in the last century.

The recognition of labyrinthine involvement in the course of inflammatory disease in its immediate vicinity, or invasion of its cavities by any pathological process of sufficient intensity to destroy or deprive of the power to respond to stimulation of their physiological function, is at the present time more clear than when the last edition of this handbook appeared.

For demonstration of the loss of function of the cochlea nerve, see Tuning-Fork Tests.

In order to demonstrate the loss of function of the vestibular nerve, one has recourse to two main tests—the caloric and rotatory. The former is the more reliable. The caloric test is done by gently irrigating the ear with water below the temperature of 60° F., employing about 6 ounces. The rotatory by rotating the patient, either with eyes closed or covered with opaque glasses, ten times in about twenty seconds. In the caloric the patient's eyes are fixed on the observer's finger either directly in front or to the opposite side. If the patient has a normal or irritable vestibular nerve, nystagmus is noticed. If no nystagmus is noticed, the nerve is not irritable, and if there is also severe vertigo, there is either a fistula into the labyrinth or a hyper-irritable nerve. In this test, with a normal nerve, the greatest excursions of the nystagmus are towards the opposite side to that tested.

Warm water gives the opposite results, but with hot water regular results are not to be obtained; therefore the test is always to be made with cold water.

The Rotation Test.—The patient is rotated first to the right, and after the results are noted, to the left.

The results in this test are thus noted: Ten rotations to right = x seconds This means that after rotating the patient ten times a nystagmus is obtained on fixing the eyes which last x seconds in the normal; this is about twenty-five seconds. When the labyrinth is not irritable no nystagmus is obtained; when much diminished it becomes lessened. Unfortunately, this test is of less value the longer the period of time which has elapsed since the lesion, as the brain seems to become more and more dependent upon the remaining labyrinth. As the effects of rotation are probably dependent upon changes in the blood-pressure, one scarcely relies upon them.

Perforation Test.—When there is a fistula into the bony external semicircular canal, compression of the air within the meatus causes nystagmus and vertigo, with a tendency for the patient to fall towards the affected side ; but when there is a large opening into the vestibule with destruction of the endosteum, the tendency to fall will be away from the lesion when the ear is syringed or the air in the meatus is compressed.

The nystagmus is usually towards the sound side, but when towards the affected side it is probably in those cases where there is a perforation of the membranous as well as the bony labyrinth.

Treatment.—Treatment will consist in removing, as far as possible, that part of the bony labyrinthine capsule within which the disease is situated, except in cases where the affection is due to a prolongation of infection from the cranial cavity. In order to do this a radical mastoid operation should be first performed. If a sinus be found into a canal, especially the external, should the symptoms indicate operation, that canal should be opened, and the canal followed until the vestibule is opened, and where advisable a second opening can be made by removal of the stapes and enlargement of the foramen ovale downwards and forwards, at the same time, by cutting away the promontory, opening the lower end of the cochlea. If a sinus is found in the region of the foramen ovale, it will in like manner be followed up (for details, see *ante*). The general after-treatment differs in no respect from that given for the radical mastoid operation.

Neurasthenia of the Auditory Nerve, or Weakness of Hearing.—By this is to be understood a condition of temporary loss of function, or of conductivity, by the auditory nerve, due to extraneous causes, which, acting on a part already the subject of some slight pathological lesion, is readily attacked. This condition includes many which are also considered under the titles of Anæmia and Hyperæmia of the Auditory Nerve.

The principal active exciting causes are overwork, both mental and bodily, worry and anxiety, over-indulgence in food, drink, or sexual intercourse, and malaria. When the cause is over-indulgence as far as the ingesta are concerned, it matters not whether this is actual or only relative to the habit of body and to the amount of exercise. Vertigo and tinnitus are frequent concomitants of the deafness, and is at times paroxysmal, a pseudo-Menière. The principal diagnostic features of this class of case are the history, together with a loss of bone-conduction quite out of proportion to the loss found in voice and whisper tests, or in the case of gouty trouble ; at times the intermittent character of the trouble, its exacerbations, and recoveries.

TREATMENT is largely general, and directed in the first instance to a correction of the constitutional trouble, and when this is corrected attention is to be devoted to the aural lesion, usually middle ear ; and here, as in all aural lesions of a hysterical and neurasthenic type, inflation should be avoided. Rest and change of scene are the two most effective adjuncts to treatment. Especially valuable is a sea voyage.

Neuritis of the Auditory Nerve.—CAUSATION.—Toxic scarlet fever, typhoid, mumps, and a few other of the exanthemata, diphtheria, influenza, and rheumatism ; drugs, as quinine, salicine, alcohol, lead, and possibly tobacco.

The toxic agents which affect the auditory nerve either cause a permanent or temporary loss of function. Of the latter are those caused by drugs, and are capable of being recovered from when the exhibition of the drug is discontinued. In this connection it is well to revert to the condition referred to as neurasthenia of the auditory nerve, under which heading malaria was included ; for one finds no deafness remaining after the administration of quinine unless malaria is also present, and although in ears with defective vessels permanent injury *might* be done, yet there does not seem to be any substantial proof of this belief.

The toxins which cause deafness, and during the course of the various fevers are permanent, and, as has been demonstrated in diphtheria, are due to direct infection of the labyrinth, are, then, due to direct action of the virus upon the end organ of the nerve.

SYMPTOMS.—In most of the cases of fevers the deafness is only noticed some time after its probable onset, but little is known of its causation; but in rheumatism the attack is sudden, and often accompanied by Menière's complex of symptoms. In alcoholic and tobacco poisoning the effect is gradual, and neither vertigo nor tinnitus are present. Tinnitus and vertigo are almost invariably transitory.

TREATMENT.—Antipyrin is advocated as a useful drug, but few data respecting its employment are available. Pilocarpin administered by hypodermic injection is the most universally employed drug, but must be pushed if any good effects are to be obtained.

Primary New Growths of the Internal Ear.—Primary new growths of the internal ear are comparatively rare. They may be sarcomata, neuromata, or epitheliomata. They will rapidly spread into the surrounding bone, and will, if the disease be malignant, penetrate into the cranial cavity. If the growth, however, be innocent, as a neuroma, the symptoms will vary according to the site and situation of the growth.

DEAF-MUTISM

Deaf-mutism is either congenital or acquired. The congenital form is due to a non-development of some portion of the labyrinth, the most constant of these errors of development being absence of one or more of the semicircular canals. In these patients no perception of sound can be discerned. They may be tested with loud sounds, as bells and whistles, or by the sharp sound produced by a piece of flat steel bent rapidly to and fro.

No treatment can be of any avail in these cases, and the sufferers should be instructed early in lip-reading.

Acquired Deaf-Mutism.—Acquired deaf-mutism is due to some inflammatory change either in the middle ear, the labyrinth, or the auditory nerve within the cranial cavity. If a child who has not learnt to speak suddenly loses his hearing, he will become a deaf-mute. Such a calamity occasionally follows acute diseases, as meningitis, scarlet fever, mumps, and the exanthemata in general; concussion of the brain will sometimes cause it.

Treatment.—In patients in whom all perception of sound is entirely lost, as carefully determined by the use of hearing tests, we have little to hope for from treatment; in sufferers who retain any perception of sound whatever an endeavour should be made to restore the function, and in such cases adenoid vegetations, if present, should always be removed. At the same time it must be clearly understood by the parents or friends that the operation in itself is only an adjunct to aural treatment, which consists in regular inflation for two or three months, and in the administration of nux vomica, with occasional doses of hydrarg. c. creta. It is, unfortunately, rarely that we obtain any result by this treatment, but, nevertheless, it should be given a trial. If it fail, the child is to be put under proper instruction in lip-reading.

Urbantschitsch has recently reintroduced a form of treatment in vogue in the early part of last century, which is to enable those deaf-mutes who still possess a dormant remnant of hearing-power again to exercise that remnant, and to build upon it an increased audition. This end is obtained by the use of methodical acoustic exercises, which may be said to have a threefold object: First, to awaken attention to acoustic impressions; secondly, to build up differential hearing; and, thirdly, to increase acoustic excitability. No case should be considered unsuitable until the acoustic exercises have been tried. They are not so suitable in school-children as they are in later life, on account of the great pains which must be taken in order that the exercises may produce any result and the large amount of time required. Neither can the result be foretold in any individual case; nor should the inability to hear tuning-forks through the cranial bones be considered as a bar to treatment.

The greater the difficulty there is in arousing the perception of sound, the more are special exercises required. These latter may be omitted in the event of the patient hearing his own voice or perceiving ordinary sounds. If the slightest acoustic perception is awakened by the exercises, the case immediately becomes suitable for further treatment.

The method of Urbantschitsch is briefly as follows: Two vowels are selected—say *a* and *o*, as they are the more readily understood. The one to be used is first indicated to the patient by the lips, and then is spoken into the ear in a loud and prolonged voice. This must be repeated until the patient perceives the sound. This may not be for several sittings, and it is better that the sittings should not be too much prolonged, but they may be often repeated. As soon as the first sound is heard and pronounced by the patient, the second vowel sound is employed to enable him to commence arriving at a differentiation of sound. One vowel after another is added, until the patient has mastered all the vowel sounds. At each subsequent lesson a consonant is added to a vowel, until the rudimentary vowel and consonant sounds are both perceived and differentiated. Gradually more syllables and combinations of sounds are employed until words are formed, and eventually complete sentences, the distance from the ear being increased as the exercises progress, and as soon as possible lip-reading is abandoned, and the exercise becomes purely acoustic. As soon as possible also it is advisable to connect the sounds made with some object which will appeal to the other senses of the sufferer. Urbantschitsch himself says that the lessons should not last more than five minutes to commence with, nor occur oftener than once a day; but as the patient progresses, so may the time limit and frequency of the séances increase. Above all other factors, regularity and the close adherence to a system are necessary; also the teacher requires to possess a clear and sonorous voice. This method may also be employed to relieve in some degree the deafness of chronic catarrhal deafness.

UNILATERAL LOSS OF HEARING OF CHILDREN

Cases occur quite frequently in which patients, children of tender years sometimes, are noticed to be a little wanting in attention, and as they get older it may be discovered or suspected that they are somewhat deaf. A careful examination will reveal in some of these cases that one ear is completely functionless, that neither by bone- or air-conduction is there any appreciation of sound. At the present time the cause of this entire loss of function is quite obscure, but the remaining ear seems to get its function or powers materially increased, so that the patients frequently are not aware themselves that they are absolutely deaf on the one side, air and bone-conduction becoming enormously increased in the sound ear.

CHAPTER XVI

LIFE ASSURANCE

The Influences of Diseases of the Middle Ear on Life Assurance.

It will be advisable to consider this question under the four following symptoms: Deafness, vertigo, tinnitus, and suppuration.

Deafness.—The influence of deafness directly upon life-expectation is not great, but a deaf man cannot be considered as an absolutely first-class life. He runs necessarily a greater risk of accident than does a man in full possession of his faculties: severe deafness in a young person who is insuring his life for its whole period should certainly subject him to a moderate increase in the premium—that is to say, an addition of five years or more to his age; a young individual affected with otosclerosis should receive at least ten years' addition. In later life—fifty years and upwards—the load need be no more than five years for absolute deafness.

Vertigo.—Vertigo, especially if severe and if the attacks are accompanied by Menière's symptoms, will necessitate a very heavy increase in the premium, or even an absolute rejection of the life.

Tinnitus.—Tinnitus, uncomplicated, is only an important factor when the applicant for assurance is of a neurotic temperament, and has begun to find the tinnitus intolerable, or when the tinnitus has commenced to take the form of voices; in the former instance the possibility of suicide must be taken into account, and in the latter the probability of the onset of insanity.

Suppurative Disease of the Middle Ear.—After the occurrence of a single attack of acute otitis media, followed by complete restoration to health, a person is not rendered unfit for life assurance at the usual rates.

An applicant who has suffered from chronic purulent disease of the middle ear in whom the perforation has healed, and who has been free from symptoms for two years or upwards, also needs no addition to his premium. An applicant in whom a perforation exists, but in whose condition there has been no active change for two years, may be accepted with a slight addition to the premium. All candidates who are the subjects of a chronic suppurative otitis media, no matter where the perforation is situated, nor how scanty the discharge, nor how long the periods between recurrent attacks, should be absolutely rejected. This rule of practice may be modified to this extent : If an applicant place himself under treatment, and report himself at a later date as having been cured for more than two years, the medical referee may then accept the proposal with an addition of five to seven years to the life. On the other hand, if the applicant has submitted to the radical mastoid operation with a successful result, no addition need be made to the assurance premium. This operation can only be called successful from an assurance point of view when the cavity remains dry and free from cholesteatoma, and is capable of free inspection through the external meatus. No applicant who has had an abscess of the brain should be accepted until a period of at least ten years has elapsed since the symptoms subsided.

Those affections of the external ear which would cause rejection would be the occurrence of malignant disease. Lupus of the external ear would entail the applicant being deferred until the disease had been eradicated and had remained cured for two years.

The general principle underlying the treatment of applicants for life assurance with suppurative otitis media is that the applicant is suffering from a curable disease, which as long as it remains untreated is dangerous to life, and that to an extent which it is impossible to estimate.

Investigation of Cases coming under the Employers' Liability and Domestic Servants Acts, etc., and of Malingering.

The most frequent class of case will be found to be those coming under the general term trauma.

In children, the effects of boxing the ear.

In servants it is probable that deafness attributed to colds or to the effect of illness, and even suppurative otitis, may be complained of.

In workmen, caisson deafness and the results of injury to the labyrinth from concussion or fracture of the skull.

In malingering one usually finds a history of injury or malaria, with either complete or more commonly unilateral deafness.

In the case of ruptured membrane, if due care is taken no ill-results will occur ; but if from ignorance or carelessness suppuration ensues, one must, in calculating the time required for a cure, and the probable loss of hearing, be very guarded—in fact, it would be impossible to give an opinion of any real value.

APPENDIX

POWDERS.

For Nasal Lavage.

1. ℞ Sodii chlorid.
Sodii bibor.
Sodii bicarb. } .. .. .. āā ℥i.
Sach. alb. .. .. ℥iii.
ʒi. in ʒx. of tepid water.

For Symptoms of Meningeal Irritation.

2. ℞ Hydrarg. subchlor.
Quinin. sulph. } .. .. āā gr. v. ad x
The powder to be given every four hours till temperature falls.

For Use in Very Severe Cases of Menière's Disease and Otalgia.

3. ℞ Quinin. sulph. .. .. .. gr. xx.
Ft. pulv. Take one every four hours.

4. ℞ Quinin. sulph. .. .. .. gr. xx.
Ac. hydrobrom. dil. .. .. ʒi.
Aquam .. .. ad ʒi.

MIXTURES.

5. ℞ Liq. hydrarg. perchlor.
Sp. vini rect.
Glycerin. } .. .. āā ʒ.
Ext. cinchona liq. .. .. .. ♏ xx.
Aquam .. .. ad ℥i.
M.; ft. dosis. Thrice daily.

For Use in Tinnitus.

6. ℞ Tinct. valer. ammon. .. .. ʒss. ad ʒi.
Sp. ammon. aromat. .. .. ♏ x.
Aquam .. .. ad ℥i.
M.; ft. dosis. Thrice daily.

7. ℞ Ac. hydrobrom. dil. .. .. ♏ xxx. ad ʒi.
Sp. chloroform. .. .. .. ♏ vii.
Aquam .. .. ad ℥i.
M.; ft. dosis. Thrice daily.

8. ℞ Liq. strychnin. hydrochlor. .. ♏ v. (increased to ♏ x.)
Ac. nitrohydrochlor. dil. .. ♏ v.
vel Ac. hydrobrom. dil. .. ♏ xxx.
Aquæ .. .. ad ℥ss.
M.; ft. dosis. Thrice daily after food.
Increase the dose by ♏ i. until ♏ xii. per dose is reached.

LOTIONS.

For Syringing the Ear.

9. ℞ Lysol .. .. ½ to 2 per cent.
10. ℞ Creolin .. .. ½ to 2 per cent.
11. ℞ Izal .. .. ½ to 10 per cent.
12. ℞ Sol. hydrarg. perchlor. .. $\frac{1}{30}$ to $\frac{1}{10}$ per cent.
13. ℞ Sol. hydrarg. biniod. .. .. $\frac{1}{30}$ to $\frac{1}{10}$ per cent.
14. ℞ Formalin .. .. .. $\frac{1}{40}$ to ¼ per cent.
15. ℞ Ac. borici .. .. ., gr. v.–xx. ad ℥i
16. ℞ Glycerin. ac borici }
Glycerin. ac. carbolici } .. āā ʒss.
Aquam .. .. ad ℥v.
M.; ʒiv. in āā ℥iv.

GUTTÆ.

17. ℞ Spi. vini rect. .. .. .. ℥i.
Twenty drops to be warmed and dropped into the ear.

18. ℞ Ac. borici .. .. .. gr. x.
Sp. vini rect. .. .. .. ℥i.
M.; ft. guttæ. As in Formula 17.

19. ℞ Hyd. perchlor. .. .. .. gr. ½.
Sp. vini rect. .. .. .. ℥i.
M.; ft. guttæ.

20. ℞ Ac. salicyl. .. .. .. gr. v. ad gr. xxx.
Sp. vini rect. .. .. .. ʒii.
Liq. ammon. acetat. .. .. ad ℥i.

21. ℞ Peroxide of hydrogen (10 vols. strength).
As in Formula 17.

For Softening Cerumen.

22. ℞ Glycerin.
Aquæ dest. } .. .. .. āā ℥i.

23. ℞ Sodii bicarb. .. .. .. gr. xxx.
Glycerin. .. .. .. ʒii.
Aquam .. .. ad ℥i.
As in Formula 17.

ANÆSTHETIC SOLUTIONS.

Aural Use. Gray.

24. ℞ Cocaine .. .. gr. x.
Aniline oil
Rectified spirit } .. .. .. āā ʒi.

This solution soon changes colour from absorption of water.

25. ℞ Sol. eucainæ, 8 per cent.
Sol. cocainæ, 10 per cent. } .. āā ℥ss.

REMEDIES FOR USE IN OTALGIA.

26. ℞ Pil. belladonnæ .. .. .. gr. ⅛
Take one pil. three or four times daily.

27. ℞ Opium aural ovoid. (Bullock and Co.)
One to be pushed into meatus. To be repeated in three hours' time if required.

28. ℞ Chloroform.
Ten minims to be dropped into an eggcup and placed over auricle.

29. ℞ Phenacetin .. .. .. gr. x.
Take one powder thrice daily.

30.	℞	Antipyrin	gr. xx.

As in Formula 29.

31. ℞ Morphia (hypodermic).

COUNTER-IRRITANTS.

32.	℞	Tinct. iodi Tinct. canth.	āā partes æquales.

Paint the mastoid daily until soreness is produced. Repeat the process as soon as the part is again sound.

℞	Quinin. bisulph.	gr. ½.

In forma pulv.

Powder on raw surface after blistering, and cover with oil-silk for tinnitus.

33.	℞	Tinct. iodi Tinct. capsici	āā partes æquales.

As in Formula 32.

34. ℞ Ethyl chloride.

Use as a spray over mastoid thrice daily.

INTRATYMPANIC INJECTIONS.

35.	℞	Sodii bicarb.	gr. vii.
		Glycerin.	♏ xxx.
		Aquæ dest.	ʒii.ss.

M.; ft. inject. Use ♏ iii. warm.

36.	℞	Pilocarpin. mur.	gr. iii.
		Aquam dest.	ad ʒii.ss.

As in Formula 35.

37.	℞	Pot. iod.	gr. i.
		Aquam dest.	ad ℥i.ss.

As in Formula 35.

38.	℞	Hyd. biniod.	gr. xvi.
		Lanolin.	ʒvii.
		Ol. pet.	ad ℥iv.

M. As in Formula 35.

VARIOUS.

MANDL'S SOLUTION.

39.	℞	Iodi (cryst.)	gr. vi.
		Pot. iod.	gr. xx.
		Menthol	gr. v.
		Glycerin.	℥i.

M.; ft. pigmentum.

IODOFORM EMULSION.

40.	℞	Iodoformi Ol. lanolini	āā ʒi.
		Ol. petrol.	ad ℥i.

M.

LISTER'S STRONG SOLUTION.

41.	℞	Hydrarg. perchlor.	$\frac{1}{8}$ per cent.
		Ac. carbol.	5 per cent.
		Aquam	ad 100 per cent.

SALICYLIC PASTE FOR USE IN ATTIC CHOLESTEATOMA.

42	℞	Ac. salicyl.	20 per cent.
		Creasoti	5 per cent.
		Emp. plumbi	ad 100 per cent.

M.

43.	℞	Ac. salicyl. Papaine Menthol	āā $33\frac{1}{3}$ per cent.

LASSAR'S OINTMENT FOR ECZEMA.

44.	℞	Salicylic acid Resorcin.	āā gr. v.
		Ichthyol	gr. x.
		Lanoline Vaseline Zinc oxide Starch	āā ʒii.

In moist eczema the salicylic acid should be omitted.

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